# Electrical Engineering

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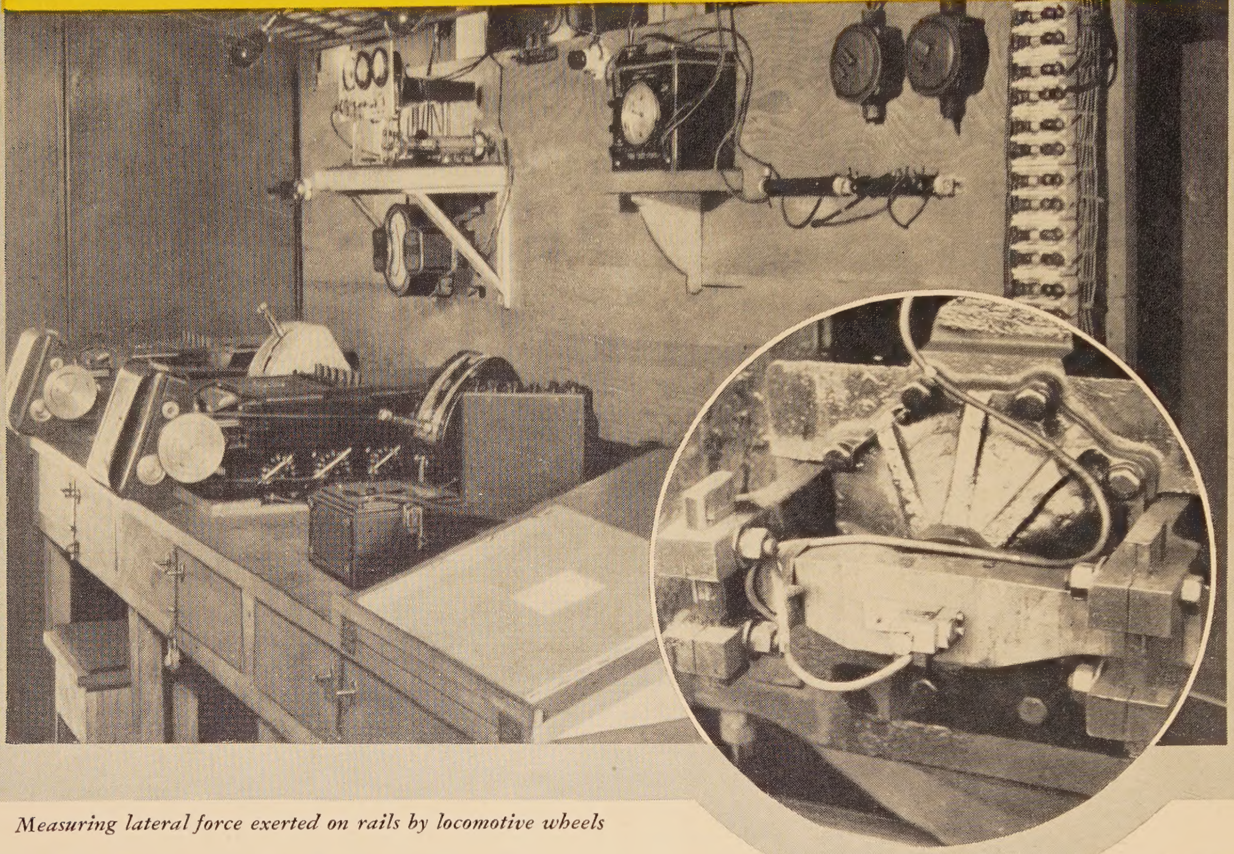
# To Measure—STRAIN
## ELECTRICALLY



*Measuring lateral force exerted on rails by locomotive wheels*

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# Electrical Engineering

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**The Cover:** World's longest pontoon bridge (1¼ miles) across Lake Washington near Seattle is lighted with 10,000-lumen sodium lamps. Photo courtesy General Electric



## Transactions Section *(Follows EE page 386; a preprint of pages 489–562 of the 1940 volume)*



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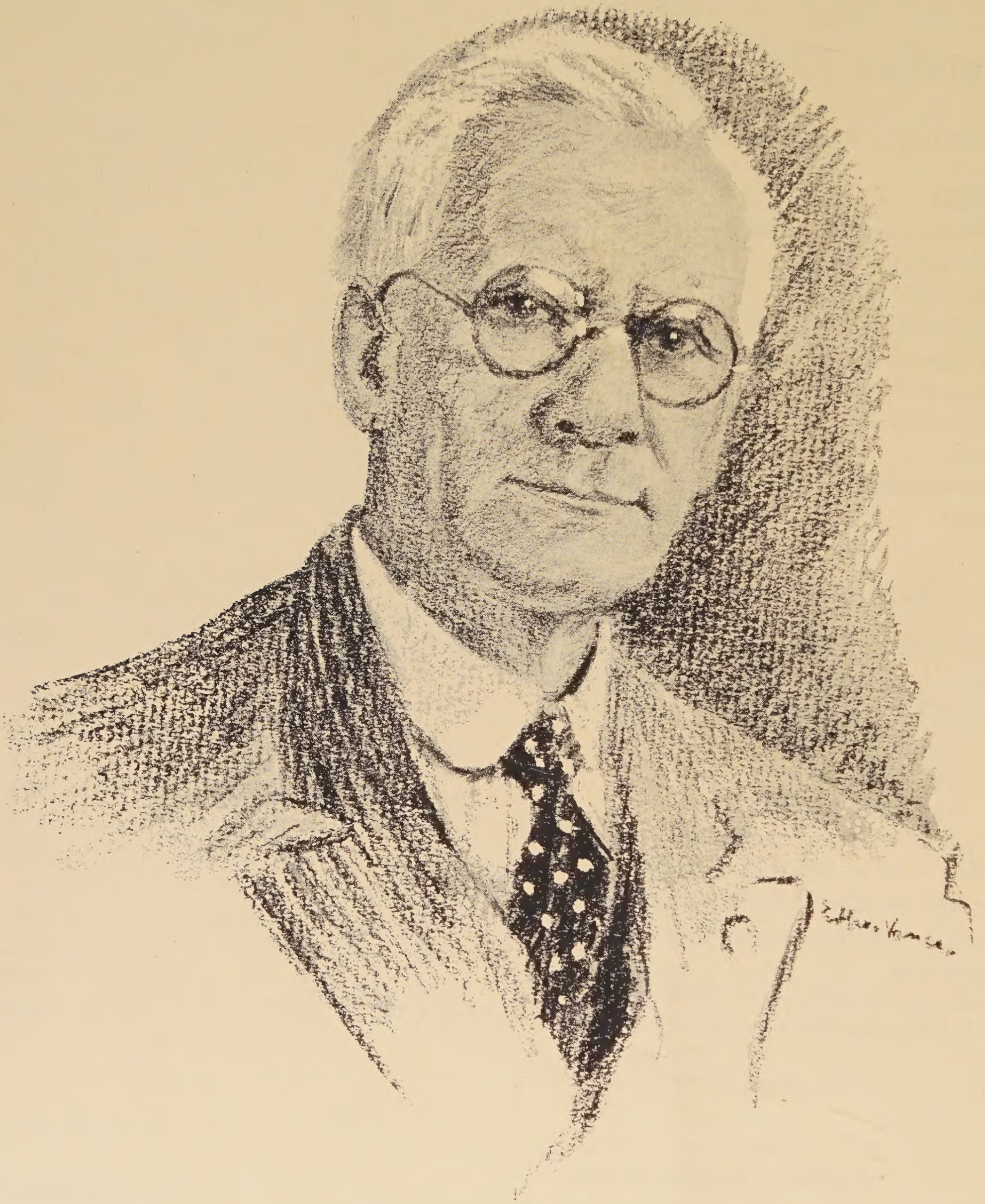

# Charles Felton Scott

## Engineer, Educator, Co-ordinator

NOT OFTEN in any profession, or in any generation, does there appear a man who follows youthful pioneering achievement by half a century of truly significant work; one who, having distinguished himself as inventor and engineer, displays equal ability as organizer and teacher. The life and work of Charles Felton Scott stand to prove that the combination can exist. One of the group of "great engineers" of the 90s, he was for 22 years (1911–33) head of the electrical engineering department of a great university, and at the age of 75 is still contributing vitally to the development of engineering as a profession. In the pattern of his rich accomplishment certain motifs recur consistently: the ability to perceive relationships, belief in co-operation, and a gift for applying the same simple scientific methods to the solution of whatever problems he encounters. One of the few surviving power-age pioneers, he is today perhaps more widely honored and more genuinely beloved than any other man in his profession.

Charles F. Scott was born in Athens County, Ohio, September 19, 1864. His father, William H. Scott, was professor of Greek and later president of Ohio University at Athens, where the son took preparatory training and the first two years of his college course. Entering Ohio State University at Columbus at the beginning of his junior year, Scott graduated with a bachelor of arts degree in 1885. He had a year and a half of postgraduate work at Johns Hopkins University, at the same time teaching in the apprentice school of the Baltimore and Ohio Railroad, and was then employed for a time by a company that was installing an a-c lighting plant in the Baldwin Locomotive Works.

### THE WESTINGHOUSE PERIOD

In 1888 began the connection with the Westinghouse Electric and Manufacturing Company that represents one of the three important aspects of Scott's versatile life—his technical engineering career. He started as night assistant in the testing room. University graduates in the electrical industry in those days were likely to begin by sweeping floors and oiling dynamos, but for the young engineer who could endure the unpromising apprenticeship there were opportunities in the rapidly developing industry that make the more dignified course of today's graduates seem dull in contrast. Within a short time Scott was working under Nicola Tesla on the development of the polyphase induction motor, which was patented in 1888. When Tesla left the company, Scott continued the work, doing much to make practical the motor for which its inventor had supplied the fundamental theory, and carrying on other important activity connected with the development of alternating current. He became assistant electrician in 1891, chief electrician in 1897, and in 1904 consulting engineer.

The early years of Scott's connection with the Westinghouse company covered a most dramatic period in the history of the industry. Alternating current, for which Westinghouse had the United States patent rights, was being developed; high-voltage power transmission was beginning; and the Niagara power project, a milestone in the progress of both, was being planned and built. Scott was one of the brilliant young engineers who were making electrical history at a rate that seems scarcely credible to the modern world that is built on their achievements.

In the history of "Niagara Power", Edward D. Adams wrote: "The reputations of the Westinghouse engineers, Stillwell, Shallenberger, Lamme, Scott, and others . . . impressed the Niagara management with the seriousness and skill of the efforts that would be made to produce the electrical machines desired, although absolutely novel in design and unique in magnitude."[1] As consulting electrical engineer on the Niagara project, Scott "acted in an advisory capacity in many important ways".[1] His great contribution was the "Scott connection," or "T connection", by which two-phase current from the generators was transformed to three-phase for transmission. He proposed its use at Niagara shortly after the Westinghouse company had secured the contract that marked an important milestone in the development of modern electric power.

The invention of the "T connection", Scott's best-known technical achievement, occurred two years before it was used in the Niagara installation. The circumstances have been described by L. B. Stillwell:

"In 1892 I was preparing plans and estimates as the basis for a tender by the company covering the transmission of several thousand kilowatts from Folsom, Calif., to Sacramento. I knew that the General Electric Company would figure on three-phase transmission, which meant three instead of four conductors and involved a difference of $12,000 in cost of copper for the transmission circuit. I called in Scott and showed him the situation. We discussed it briefly and he expressed the opinion that the problem could be solved. Then he withdrew to another office, and within a remarkably short time returned with his two-phase three-phase connection of transformers—a perfect solution. In the light of present-day knowledge this may not seem remarkable, but in 1892 few were competent to deal promptly with problems of this type, and the incident illustrates admirably Scott's ability in applying theory to practical problems."[5]

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The portrait on the facing page is by Esther Vance, New Haven, Conn.

1. For all numbered references, see list at end of article.

The same sort of ability and the same direct approach and simple methods have characterized Scott throughout his life, whether he was solving technical problems, teaching students, or getting men and organizations to co-operate for objects of which the value was generally admitted but the achievement considered impossible. In every field of his activity, he has been able to see the essentials of a problem, recognize the simplest method of solving it, and co-ordinate the means available toward the solution.

Scott's first patent, a joint one for a lightning arrester, was taken out in 1892. It was followed by more than 50 others of which the majority related to power transmission and distribution, although the scope of his interests is attested by scattered patents on other aspects of the industry. Power transmission, however, was his particular concern for many years. He contributed in 1892 the first AIEE paper on high-voltage transmission, a description of the system he had designed and installed at Telluride, Colo., a pioneer installation unique for its time. It used 3,000 volts single phase and transmitted 100 horsepower for three miles. Scott was associated with other early transmission projects, and was chairman of the power transmission section of the International Electrical Congress, held in St. Louis, Mo., in 1904.

In his work with transformers, he was the first to apply water cooling. With R. D. Mershon, he was the first to measure the power loss caused by corona. He did important work in connection with early railway electrification, including studies of means for reducing inductive disturbance on communication circuits and the development of an effective "balanced plan" for supplying power to railroads.

Scott's technical achievements during his "Westinghouse period" would in themselves be enough to insure his fame. In addition, however, he was contributing effectively to the development of the professional aspects of engineering, especially through his leadership in the Institute. At the same time, his interest in engineering education was beginning to take shape. His career as an educator really began with the training of young men in the Westinghouse company, and the student training courses that are an important part of the company's program today are the logical outgrowth of his early work. In 1902 he founded the Westinghouse Electric Club, for the purpose of providing lectures, conferences, and advanced study for the young engineers in the company, and two years later established the *Electric Journal*, primarily to preserve for successive groups the lectures given at the Club's meetings. He was chairman of the publication committee until he left the company. The magazine's first editor, paying tribute 30 years later to his "guidance, experience, and inspiration",[7] also points out that although, "by training and position an engineer, in disposition Doctor Scott has always been an educator."

## PROFESSOR OF ELECTRICAL ENGINEERING

The opportunity to devote himself primarily to education came in 1911, at the Sheffield Scientific School of Yale University. There, the electrical-engineering course, until then under the department of physics, was growing in importance. "The belief that the time had come to place it on a more distinctly engineering basis (without interfering with training in the fundamental sciences) led to the creation of the chair of electrical engineering to which Scott was called. He was chosen as a recognized authority, known especially through his study of alternating current in the transmission and utilization of power, and also because of his extensive connection with the training of apprentices at the Westinghouse company."[2]

When he went to Yale there was no laboratory for electrical engineering, but "Scott's presence, and the desire of the university to utilize fully all he could offer to graduates and undergraduates made it necessary to secure as speedily as possible needed facilities for expansion of experimental work in the electrical field."[2] The result was the Dunham Laboratory of Electrical Engineering, gift of A. C. Dunham, president of the Hartford Electric Light Company, which was ready for use in 1913. When the building that now houses the electrical-engineering department was designed, Scott counseled flexibility to meet possible future conditions. The developments of subsequent years have justified his foresight in a number of instances.

From 1911 until 1933, when he retired from active teaching and was made professor emeritus, Doctor Scott headed the department of electrical engineering at Yale. Of his work there one of his colleagues writes, "Professor Scott's outstanding contribution to education at Yale was in his simple approach to relatively complicated problems. He taught the student how to arrive at correct conclusions by the application of the simplest mathematics. Also deserving special mention was his correlation of mechanics, thermodynamics, and electrical engineering through illustrative problems, such as acceleration of street cars, use of flywheels in steel mills, and conduction of heat through various materials. He would direct the students' attention to the universal laws governing these different fields—usually to their considerable surprise. He deserves much credit for the simplicity and effectiveness of his method of approach."[8]

## BUILDING A PROFESSION

In addition to his direct contributions to engineering education as teacher and administrator of the electrical-engineering course of a great university, Doctor Scott has made the training of engineering students a major object in the third of his spheres of activity—his service to the engineering profession. Here also, as in education and in engineering practice, his accomplishments constitute a career in themselves.

His ability, already emphasized, to reduce a problem to its essentials and suggest a simple and logical solution has been combined in his work for engineering as a profession with an active recognition of the interrelation of the work, education, and professional organization of engineers. His terms as president of the AIEE (1902–03) and of the Society for the Promotion of Engineering Education, nearly 20 years later, both marked conspicuous advances in the history of the societies, and his influence

can be detected in nearly every major move toward effective co-operation that the engineering societies have made in the past 40 years.

He became president of the AIEE in 1902, as a young man of 38, with the uncomfortable responsibility of following in office Charles P. Steinmetz. In his own words, "I acquiesced with some misgivings, as the alternatives seemed to be to continue if possible on the same level or to slump; but I had not counted on the aid and support others might give."[4] He gives his associates well-merited credit for their share in originating the program that made his presidency outstanding, but it was Scott as president who put into effect the plans outlined in his inaugural speech.

His program included: larger membership, more papers and discussions, local Sections, Student Branches, collection of data, support of the library, permanent quarters for the Institute, and co-operation with foreign engineering societies.[6]

During his presidency, membership increased more than 50 per cent. With the first systematic plan for local activities to be put into effect by any national engineering society, local Sections, of which a few were already in existence, began to sprout rapidly, accounting for much of the increase in membership.

The idea of inaugurating Student Branches in the colleges, to give students "an insight into the problems and practices of the profession, without waiting for a sudden plunge from theory to practice on graduation", arose, according to Doctor Scott's account, from a discussion of the rate at which the electrical industry was developing. It was then doubling every five years, and Scott was struck with the need for trained men that would arise if the curve continued to mount. "I had taken it for granted that the Institute was to promote the arts and sciences relating to the utilization of electricity through adding to knowledge. . . . Should not the Institute develop men was well as ideas?"[4] The idea appealed at once to the colleges and Student Branches began.

One way of realizing the objectives of more papers and discussions and collection of data was found in Scott's appointment, at the suggestion of R. D. Mershon, of the high-voltage transmission committee, the Institute's first technical committee.

### PROPHET OF CO-OPERATION

The objectives of supporting a library and finding permanent quarters for the AIEE were soon to be merged in a broader program, when Scott began to consider co-operation on a large scale among the four national engineering societies. Toward the end of 1902 he made a speech on "The Engineer of the 20th Century",[4] in which he made certain predictions. These seem startlingly prophetic today—until a look at the record shows how great a part Scott himself has played in bringing about their fulfillment.

Inspired by the establishment of the John Fritz Medal as the first joint project of the engineering societies, he predicted a building for all the engineering societies, an "engineering congress . . . representing all the engineering professions and supported by the great union of national engineering societies", and a great national network of engineering organizations, connected in national and local groups.

The Institute's library dinner, early in 1903, gave him an opportunity to suggest the idea of a joint engineering-societies building to Andrew Carnegie, who had rejected an earlier request for funds for an AIEE building. Carnegie was interested, and when Scott and others presented definite plans, gave the funds for the building. As chairman of the building committee Scott had the difficult task of achieving in practice the co-operation in which he believed so heartily. His accomplishment is attested by the Engineering Societies Building, dedicated in 1907, and managed by United Engineering Trustees, Inc., in which the national societies of civil, mining and metallurgical, mechanical, and electrical engineers are jointly represented.

The organization necessary to operate the Engineering Societies Building was given a charter that enables it not only to administer the building but to handle funds for the advancement of engineering. When in 1914 Ambrose Swasey was considering the establishment of a fund for engineering research, Scott called his attention to the latter provision. Thus Engineering Foundation, co-operative research agency, was set up as a function of United Engineering Trustees, Inc.

The "engineering congress" predicted in 1902 has been approximated by the formation of American Engineering Council, a joint agency which provides engineering and allied interests with a voice in public affairs. It came about as a result of the need for engineering counsel when the United States entered the World War in 1917. The organization set up at that time was reorganized after the war, with Scott as an AIEE member of the committee selected to plan its future. He served on the Council's administrative board from 1921 to 1933.

The fulfillment of the third part of the 1902 prophecy may be seen in the variety of projects in which national engineering, scientific, and other societies work together today, and in the many state and local engineering organizations in which local Sections representing all branches of the profession are united. Considering his widespread influence, through the AIEE and other organizations, it is probable that Scott's reiterated urging of co-operation has had no small part in bringing about the climate of opinion in which it has thus flourished.

An obvious medium for Doctor Scott's interests and talents was the Society for the Promotion of Engineering Education, which sought him as president in 1921. He demurred at first, feeling himself too busy to undertake the work, but having accepted the position, galvanized into effective action a body which he described at the time as "ponderous and topheavy".[9] Again he urged local activity, repeating the pattern he had instigated in the AIEE and which had been followed in the formation of local Sections by all the engineering societies; and again he secured results. Recognizing that the function of the SPEE must be "to develop leaders who can train engineers", he drove home the idea at meetings of the

society and in its publication, endeavoring to draw from the members ideas as to how it could best perform that function. At his instigation a development committee was appointed, on which he served, and which recommended the appointment of a board of investigation and co-ordination, to make a comprehensive study of engineering education in the United States and other countries.

Turning his attention to financing the proposed survey, Doctor Scott secured funds from the Carnegie Foundation and other sources, including the Engineering Foundation and engineering societies. Doctor William E. Wickenden, now president of the Case School of Applied Science, was director of the survey, and Doctor Scott chairman of its supervising board. Five years of fact-finding, seven seasons of summer-school sessions for engineering teachers, and two European trips by the director culminated in a comprehensive report, the first volume of which was published in 1930 and the second in 1933.[3] The findings of the survey provided a basis on which engineering education could be evaluated and its future intelligently planned. Doctor Scott's contributions are suggested indirectly in his report as chairman, published with the findings of the investigation, in which he says, "What engineering education must have is a guiding philosophy based on a clearer visualization of the place of engineering in modern life."[3]

One of the conclusions reached in connection with the survey was that the development of engineering education in the directions suggested by the survey findings could best be achieved by the co-operation of the schools under the guidance of a central body. The findings of another survey, a study of the economic status of the engineer made by The American Society of Mechanical Engineers during the early 1930s, pointed in the same direction. The result was the formation in 1932 of the Engineers' Council for Professional Development, on which the national societies of civil, chemical, electrical, mechanical, and mining and metallurgical engineers, the SPEE, and the National Council of State Boards of Engineering Examiners are represented, and of which United Engineering Trustees, Inc., is treasurer. Doctor Scott has been active in ECPD since its organization, served as its chairman 1935–38, and is now chairman of its committee on professional recognition, and a member of its executive committee. The organization is the embodiment of his belief that "the development of the young engineer is the joint responsibility of the schools, the professional societies, and the registration boards."[10]

Doctor Scott might seem to have taken his own full share of that "joint responsibility," through his work at Yale and in the societies; since 1935 however, he has been active also in engineering registration, as chairman of the Connecticut State Board of Examiners and a member of the National Council of State Boards of Engineering Examiners. He represents the latter body on ECPD, was vice-president 1937–38, and since 1938 has been its president.

Along with his many other duties and activities, Doctor Scott has had a record of continuous service in the AIEE that has been equaled by few other members, and by none now living. He joined the Institute in 1892, transferred to Member grade in 1893, and to Fellow in 1925. He has been a manager (1895–98), vice-president (1899–1901), president (1902–03); member at various times of many of the Institute's committees and Institute representative on many other organizations. At present he is a member of the committee on Student Branches and Institute representative on the Thomas Alva Edison Foundation. He was one of the founders and the first chairman (1921–22) of the Connecticut Section, and was also founder of the Yale Student Branch. In 1929 he was made an Honorary Member, and was awarded the Edison Medal, the highest Institute honor, for that year, with the citation "for his contributions to the science and art of polyphase transmission of electric energy." In 1930 he was awarded the Lamme Medal of the Society for the Promotion of Engineering Education, which is conferred "for accomplishment in technical teaching or actual advancement of the art of technical training."

The degree of master of arts was conferred on him by Yale University in 1911, and he has received four honorary doctor's degrees: doctor of science from the University of Pittsburgh in 1912 and from Ohio State University in 1937; doctor of engineering from Stevens Institute of Technology in 1912 and from the Polytechnic Institute of Brooklyn in 1935. In addition to the various society affiliations already discussed, he is a member of The American Society of Mechanical Engineers, the Engineers' Society of Western Pennsylvania, of which he was president in 1902, the Illuminating Engineering Society, American Philosophical Society, Sigma Xi, Tau Beta Pi, and an honorary member of the Connecticut Society of Civil Engineers.

### "DIAMOND JUBILEE"

In recognition of Doctor Scott's lifetime of achievement, a number of special celebrations were arranged in honor of his 75th birthday, which was September 19, 1939. A testimonial dinner, sponsored by the AIEE Connecticut Section, and held in New Haven, Conn., on his birthday, was a gratifying example of the co-operation he has urged, as representatives of the American Chemical Society, American Institute of Architects, American Society of Civil Engineers, American Society of Metals, American Society of Mechanical Engineers, Connecticut Society of Civil Engineers, Kiwanis Club of New Haven, AIEE Yale Branch, and Yale University joined with the AIEE to do him honor.

During 1939 and 1940, many AIEE Student Branches have held "Scott diamond jubilee" programs in recognition of Doctor Scott's attainments and his special position as founder of Student Branches. Doctor Scott attended the first of these meetings, which was held by the Yale Branch March 17, 1939, and has attended a number of others since. At about 75 of these Branch meetings, motion pictures depicting Doctor Scott's career have been presented. In response to a request for a letter of greeting for occasions when he could not be present, Doctor Scott supplied the characteristic summary of his own career, which follows.

"My impression on seeing the film," he wrote, "was that it was a fairly true picture of the kind I have tried to make. It seemed to me that the career I was presenting was one in which many instances had a common background. I realized a situation. I saw in it a problem, a need, and after a little simple straightforward thinking, I realized that maybe something could be done about it. And I set about in a simple way to do a few little simple things, starting along a new path. The principal element in success lay in the fact that I kept at it. At least, I kept at those things which did materialize. There are many others, bygone possibilities which I have not mentioned, and many of which I have forgotten; but in the long run it is not what a man has not done, but what he has done, that really counts. Half the things that he seems to have done are due to the efforts of others who have aided in bringing about results."


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# Some Needed Improvements in Engineering Education

***A noted industrialist* points out some of the shortcomings of our present system of engineering education and suggests some needed improvements***

THERE are at least five different features in our present-day technical education which are justly subject to criticism: (1) trend toward specialization in undergraduates courses; (2) lack of proper standards of selection of students to be admitted to engineering courses; (3) failure to develop in the student the habit of thorough understanding of subject matter and processes; (4) insufficient emphasis placed on development of student personality; (5) examinations and student grading which are not the true test of student ability desired by the employer. These, of course, do not each apply equally to all institutions, but can be accepted as fair criticism of the average institution.

It would seem that there is one underlying error common, at least in practice if not in theory, in most of our institutions to which these various faults may be traced. This is the failure to appreciate that the *chief objective of a technical education should be to train the student in logical thinking and develop his creative imagination; that it should be aimed primarily toward the acquisition of power rather than toward the amassing of factual knowledge.*

## UNDERGRADUATE SPECIALIZATION

The trend toward following the latest educational fad of the day to the injury of sound, basic education is a serious problem in all of our engineering colleges. It is the consensus of employers of technical graduates that specialization in an undergraduate course is highly undesirable for the following reasons:

1. It takes valuable time of the students which may be employed in obtaining a more thorough understanding of, and training in, the fundamentals of engineering and their broad, rather than specialized, application. Our courses in technical colleges are already overcrowded and are in need of simplification.

2. An overcrowded curriculum leads to superficiality rather than thoroughness. Above all things, the engineer must be thorough. Thoroughness, which includes and emphasizes understanding, should be the first objective of engineering training.

3. With few exceptions, current engineering practice in special fields cannot be taught successfully to undergraduates. The newer arts are advancing with exceeding rapidity and textbooks are out of date almost before they are printed. Such courses can be taught successfully only by specialists who are practicing engineers, and, therefore, taught as lecture courses. It is much better that the student should gain his specialized knowledge in actual practice.

4. Probably more than 90 per cent of the students do not follow the field in which they have specialized when at college. Circumstances and opportunity for employment play the most important parts in the ultimate selection.

5. It adds unnecessarily to the over-all cost of running a technical college. Cost of instruction in, and operating laboratories for, specialized fields is all out of proportion to the cost of the more important fundamental instruction.

## INADEQUATE STANDARDS OF ADMISSION

There exists a very subtle yet definite competition among our technical schools for either numbers or quality of students. This leads, on one hand, to putting forth undesirable undergraduate curricula as window dressing to

* Excerpts from a paper "The Employer Suggests Needed Improvements in Our System of Technical Education" by W. H. Carrier, chairman of the board, Carrier Corporation, Syracuse, N. Y., presented at the semiannual meeting of The American Society of Mechanical Engineers, Milwaukee, Wis., June 17–21, 1940.

attract students, and, on the other hand, to the admission of some students in colleges who are unqualified for an engineering course. In general there is insufficient consideration given to student aptitude and there are inadequate requirements for admission to the course of the type of ability needed in engineering.

It may be assumed that most engineering students have an interest in their work. But more than this is required: They must have natural analytical ability. This is the real criterion of whether they should go to a trade school or take an engineering course in a university.

Unfortunately, high-school standings alone cannot be taken as sound criteria of the student's analytical ability. The increase in the age of employment, combined with compulsory education, have put into our high schools large numbers who are not interested in further instruction, as well as those who have not the ability for high-school work. This necessarily lowers the standards in many of our high schools and tends to mechanize secondary education. Entrance requirements must be revised to take into consideration definitely poorer standards of secondary education. This means that the candidates should be qualified for entrance into engineering courses by a suitable minimum college entrance examination. This should partake of the "intelligence test" type of examination to test natural thinking and reasoning ability, and should be supplementary to the qualifications indicated by high-school or preparatory-school standing. Evidence of adequate training in English should be required through examination at entrance, and further training in this subject should be provided during all four years of college.

The desirable educational standard can be made possible in engineering colleges only by the selection of the ablest from a number of applicants. This may seem severe, but it must be remembered that even now there are many more engineering graduates in this country than can be absorbed profitably by industry. Industry has no use for "duds," and the preliminary sorting out could be done most soundly and economically at the engineering college.

### SUBJECT MATTER VERSUS MENTAL TRAINING

As it has been pointed out, our engineering schools seem to vie with each other in publicizing extensive undergraduate curricula in which subject matter is stressed rather than training. Herein lies the cause of many of the principal defects observed by employers in our present day education. The student is expected to learn more and more in a given time and the courses must be made "easy" so he can accomplish the work laid out in the curriculum. To obtain high or even passing marks, he must memorize extensively; he cannot take time to think. The main purposes of an engineering education—a thorough understanding of principles and training in the use of the mental "tools" of the profession—are thus defeated. Training in thinking is far more important than the mere acquisition of factual knowledge. Employers want graduates trained in logical thinking, in habits of thoroughness, and in the scientific method of approach.

In engineering education, the aim should be to have no fact or theory accepted until it is first thoroughly understood. Memorizing without thorough understanding does not develop the habit of mind that is so necessary in later life to the successful engineer. On the contrary, it leads to a habit of taking things for granted, and often to a feeling of mental helplessness and inferiority fatal to mental progress in later life.

The engineer who advances the boundaries of his profession must have curiosity and an inquiring mind. These natural mental attributes should not be deadened or stultified in the process of technical education, but should be stimulated and developed. Teaching, so far as possible, should be through guidance rather than through enforced assistance. The inductive method should precede the classical, and commonly overdone, deductive method.

Furthermore, it is doubtful if our colleges today have the properly trained personnel in sufficient numbers to follow successfully any system of instruction other than that which is now so generally employed. The majority place too much dependence on slavish following of texts which are written more from the standpoint of reference books than teaching texts. Real teaching must be independent of such texts and must be individualistic with the fundamental educational aim in view. Such teaching cannot be mechanized. The text should be used primarily as a review and as a means of consolidation of what has already been taught.

Very much more time should be allotted to the mastery of the elements of a subject largely by the inductive method, and very much less time spent on the presentation of the more extensive details of the subject. Thoroughness should be aimed at rather than completeness. Besides, the lecture method of presentation is often overdone and wholly fails to accomplish the purpose for which it is intended.

To improve our methods in technical instruction, instructors must be far better trained in teaching methods and it must be recognized that such training is equally if not more important than the proper mastery of the subject itself by the instructor. There is today no adequate training in colleges for our instructors in their art. This should become a faculty duty, and must be so if we are to improve our method of education. Instructors must be taught how to teach and be imbued with the proper ideals of education. Today *we have many teachers but few educators.*

To be successful in undergraduate work, our faculties must be headed by great educators. The best educators, contrary to common practice, should be placed in charge of freshmen and sophomore classes where it is necessary to start the student on the right path, and the best talent should not be left for the junior and senior classes as at present.

### DEVELOPMENT OF STUDENT PERSONALITY

There is a tendency in our schools to overemphasize the technical side of education at the expense of the human aspect. The engineer's success depends fully as much on his ability to deal successfully with human

problems as it does upon his ability to deal with mechanical problems. It has been truly stated that few engineers lose their jobs because of lack of technical ability. Jobs are lost largely because of failure in human relations.

The importance of this phase of education is becoming more appreciated in some colleges. It is usually emphasized in so-called courses of administrative engineering, but it should not be neglected in *any* technical course. It is almost as important for the success of research engineers as it is for those in executive positions.

### SYSTEM OF STUDENT GRADING

Another failure of engineering schools, from the employer's standpoint, is that he finds difficulty in selecting a man on the basis of his standing in college. The employer can obtain some idea of the personality of the student from an interview, but he must rely wholly upon the college standing of the young graduate for an appraisal of his mental ability. Since today a student's standing, as evidenced by his "marks", merely indicates his application, which is valuable, and his memory ability in memorizing facts and formulas, it does not disclose, at least independently, his ability in perception and reasoning which is one of the chief characteristics in which the employer is interested.

To appraise the student better of his educational progress and to aid the employer in his judgment in the selection of engineering graduates, an entirely different system of marking must be employed. Far greater stress should be laid upon a thorough understanding of principles and their application, rather than upon factual knowledge or facility in engineering calculations.

# Engineering and Research for American Defense

L. A. HAWKINS
MEMBER AIEE

***An address delivered at the AIEE 1940 summer convention, Swampscott, Mass., June 24–28***

NOT LONG AGO I heard an engineer, whom I regard highly, say that in his opinion engineering and research were quite similar. In spite of my great respect for his ideas, I must disagree. Research demands the willingness to try anything once, however small the chance that the result will be satisfactory. The engineer on the contrary must restrain with balanced judgment his impulses toward novelty. His profession calls for a degree of conservatism. While he should be open-minded and receptive to new ideas, he should weigh the chances before going ahead. An engineer has well said that you never know how good a design is until after you have changed it. But that same conservatism may be fatal to success in research.

The reason is that the engineer deals with relatively high degrees of certainty so that a high percentage of success is expected and required in engineering development. He who cannot attain and maintain that percentage is a poor engineer, and is likely soon to be seeking other employment. But research deals largely with unknowns, so that one hit in six to ten times at bat is a good average, and that hit may come from the most unpromising experiment of all, though in that case the result is likely to differ more from expectations than a home run differs from a bunt.

Doctor W. R. Whitney (General Electric vice-president in charge of research) has said, "Any fool can tell me why it is useless to try an experiment. I want the man who will think of new experiments to try."

Mention of Doctor Whitney reminds me that only last week I acquired a new word from him—"serendipity." It may be found in Webster's International Dictionary, but I imagine it is a stranger to many of you as it was to me a week ago, although it signifies a quality invaluable to a research man and far from valueless to an engineer. It is defined as the gift of finding useful things not sought for. It was coined by Walpole nearly 200 years ago to apply to a story he had read of "The Three Princes of Serendib" (which is another name for Ceylon) who in their travels discovered by chance or sagacity things they did not seek.

The more I think of it, the more convinced I become that a very large part of the progress of mankind has been due to serendipity. You remember Charles Lamb's essay on the origin of roast pork—a perfect example of serendipity. So must have been the genesis of glass making, of refining and tempering metal, of the mariner's compass, of the sailboat, and of countless other things. The stories of Newton's falling apple and James Watt's dancing kettle lid may be apocryphal, but they at least symbolize the eternal truth that our knowledge has advanced and our civilization developed because certain individuals had the gift of seeing gold in what to the rest of the world was common clay.

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America was discovered through serendipity. So was the planet Neptune. It was serendipity that led Galvani, Oersted, and Faraday to the discoveries on which our electrical industry was based. Serendipity in Goodyear created the rubber industry. It led Nobel to the invention of dynamite, Perkin to coal-tar dyes, and Roentgen to X rays. These are only a few of the multitudinous examples that might be cited. In the General Electric research laboratory, such things as the gas-filled lamp, the Coolidge X-ray tube, the radio power tube, the Tungar rectifier, atomic hydrogen welding, copper brazing in hydrogen, and the inductotherm arose from serendipity. Chance played its part in all of them, but it was chance operating in the presence of a keen observer. As Pasteur said: "Chance favors the mind that is prepared."

Whitney suggests that serendipity is the reaction to an observation of that store of memories, knowledge, and mental habits which we call the subconscious mind. It is a tempting thought to pursue, but I can give no more time to this subject. If you wish more, you may find it in an article by Cannon in the March *Scientific Monthly*. I have divagated too far from my comparison of research and engineering. I shall return to it with the remark that research, as an offset to its relative uncertainty which I have mentioned and as a result of the novelty of the fields it is exploring, offers far more opportunity for the exercise of serendipity than does engineering.

I am stressing the difference between engineering and research because it is most desirable that engineers and research men should fully understand each other, for understanding is essential to real co-operation, and co-operation is essential to smooth and rapid progress. Engineering and research are complementary. Each is dependent on the other. The business of engineers is to apply scientific facts for useful ends. Scientific facts are their most important raw material. Without a continuing supply, engineering progress must slow down, and the only source of that supply is research. The research man's job is to discover new facts, but without engineering applications of those facts research would be practically sterile.

So if you engineers are tempted to regard the research men you come in contact with as visionary, lacking in judgment, impractical, with no sense of values or of time, remember that you may appear to them as obstructive, moss-backed, and blind to opportunity. Also remember that they are compelled, like any other salesmen, to strive to get your point of view, for you are their customer for their stocks in trade—the new facts they have discovered and the new ideas those facts suggest—while you are under no compulsion, except the realization on your part that mutuality of understanding is demanded by the true interests of both.

I do not mean to imply that research men and engineers have been at loggerheads in the past. I have in mind only that the fullest co-operation is demanded now as never before.

Past co-operation has indeed been fruitful. American engineering, aided by research, has made the United States by far the most powerful industrially. Electrical engineering particularly has so developed the potentialities of electricity as to make it the lifeblood of our civilization, so that if the supply were suddenly cut off it would bring unparalleled catastrophe. To evoke that mighty genie, and to make it the omnipresent, ever ready, efficient, inexpensive, and indispensable servant it has become, has required engineering ability of the highest order. The AIEE may well pride itself on the magnificent record. And if research has often supplied the tools, it detracts not one bit from the credit due to engineering. Rather it is all the more to the credit of engineers that they have been quick to grasp those tools and apply them effectively. Why then should I plead for still more effective co-operation between research and engineering? It is because I foresee its need in the immediate future.

It would be delightful indeed if we could continue for another 40 years, or even for one more year, such peaceful and beneficent developments as have engaged us with only a brief interruption through the last four decades. But I see no hope that that may be. The world around us is changing most horribly for the worse, and we must face about to meet that change. As citizens and as engineers we must profoundly alter our lines of thought and our activities. We must awaken from our dreams of fancied security and face the stern reality of imminent catastrophe. As citizens we must prepare for such sacrifices as we never before in our lifetimes have been called upon to endure. As engineers we must demote to a secondary place our efforts to promote the peaceful industries and must devote our minds and hearts primarily to the problems of war.

Such diversion of engineering effort to the service of the war Moloch was accomplished years ago in the totalitarian states of Europe. While we have been effectively developing the potentialities of engineering to further the industrial prosperity of the United States and the welfare of its people, in those other states those potentialities have been focused on weapons of destruction and slaughter. The result has been the creation of such a powerful war machine as the world had never seen nor dreamed of. And now that fearful machine is rolling ruthlessly forward, laying waste everything in its path, crushing out the lives of millions, enslaving one free people after another, stamping out liberty, justice, and human dignity, and forcing more and more of the world into abject subjection to cruel, intolerant despotism.

Today the British fleet is our sole remaining defense in Europe. If that passes into Hitler's hands we shall be left to face, practically singlehanded and at terrible odds, a hostile totalitarian world. Let us not delude ourselves with thoughts of the Atlantic as a barrier nor dreams of the solidarity of the western continents. If the British fleet goes, Hitler's power will extend directly to our shores. Already his fifth column is active in this hemisphere. More than one South American nation is threatened by internal disorder and possible revolution through Nazi machinations. Europe, not the United States, is the natural customer for their agricultural products. Their commercial interests tend to turn them from us to Hitler. If the British fleet goes, we may find ourselves fighting

practically singlehanded against a malignant enemy, armed to the teeth, terribly outclassing us on land, on sea, and in the air.

The Nazi war machine cannot be stopped by wishful thinking. It cannot be stopped by hastily improvised defense, however heroic. It can be stopped only by a machine more powerful than itself, and the creation of that machine is largely the task of engineers. The Nazi Juggernaut was created by engineering, and it is only by engineering that it can be destroyed. To accomplish that destruction must become our immediate prime objective, taking precedence over all other aims, even to their total exclusion if they would interfere with, or delay, its achievement.

Research too must bend all its energies to the same end. The fascinating search for truth for its own sake must be temporarily abandoned, and thought and effort concentrated on the problems of military preparedness. All our research facilities and brains should be devoted, so far as they can be so employed, to the special problems arising from military engineering developments. Research and engineering must work together as never before to the attainment of a single end.

We cannot longer afford to indulge ourselves in the luxuries of peace. All the principles, ideals, and institutions we hold most dear are threatened by ruthless aggression. They were bequeathed to us by our forefathers at the cost of blood and sacrifice. We would be recreant sons, unworthy of our great heritage, were we not quick to make all needed sacrifice to preserve it.

But what can we do, now, as individuals? How make a start on our urgent task? Before we can do effective war work in research or engineering we need many things. We need definite information on the problems of army and navy and on the present status of attempts at their solution. We need the closest kind of co-operation between government, industrial management, and labor in order that we may organize, finance, and execute the mighty task ahead. To achieve this we must first do our part as citizens, before we can play our roles as engineers or scientists.

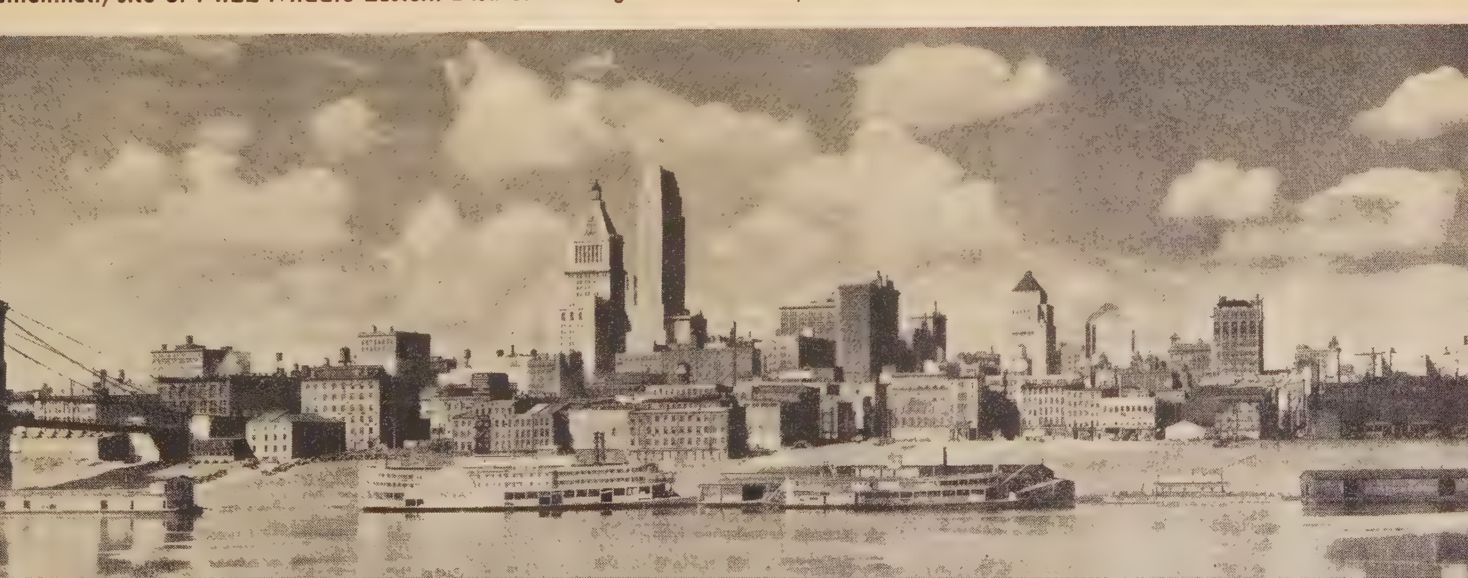
First of all we can prepare ourselves. We can orient our thoughts away from things which have become secondary, and toward our major task and the sacrifices it demands. We can try to face the facts clear-eyed, and with minds undrugged by wishful thinking. Next, we can help others to see clearly, to cut loose from such facile optimism as recently led 500 American scientists to join in a cry to the President for peace, when there is no peace and can be none so long as brute force seeks to dominate the world. Finally, as citizens, we can help to bring pressure to bear on our governmental leaders, executive and legislative alike, to tell the people the truth, to mobilize the latent patriotism and courage of the nation, to organize the national resources, and the needed channels of information, to give American industry a chance freely to exert its mighty powers to bring preparedness plans to quick fulfillment.

Then will come our opportunity. American engineering, aided by American research, has made us industrially by far the most powerful nation in the world. We produce and use nearly one-third of all the electric energy produced in the world, and our standards of living are the envy of all other countries. That same engineering ability, backed by ever strengthening research facilities, can surely demonstrate its superiority in the arts of war as it already has in the arts of peace.

Give us our chance, and give it to us now. The monstrous Nazi machine is on its ruthless way. Already it has crushed the democracies of Western Europe. Britain alone, with her fleet, now stands between ourselves and it, and who knows how long she can endure? Give us the chance before it is too late. Americans are ready to fight and sacrifice and die for their country and their liberties, but they cannot bare-handed withstand the super tanks and bombing planes. It is we engineers who must arm them. So again we cry to our government, "give us the chance and give it now."

We, who are proud of our profession, cannot suffer that future historians shall say that it was engineering that caused the black-out of liberty, the annihilation of all that was best in our democratic civilization. Rather let it be said that, when engineering tools in the hands of brutal despots threatened the liberties of the world, it was American engineering that arose in its might and created impregnable mechanisms of defense to the end that "government of the people, by the people, and for the people" did "*not* perish from this earth."

Cincinnati, site of AIEE Middle Eastern District meeting October 9–11, is here seen from the Kentucky shore of the Ohio River



# Transportation as a Social Problem

***Divergent points of view as presented at a forum held jointly by the AIEE and the American Engineering Council in connection with the Institute's 57th summer convention***

## The Railroads Can Do Their Job

ROBERT S. HENRY

Assistant to the president, Association of American Railroads

Most of us have seen trains, but there are many, many people in the world who have never really seen a railroad, who have never seen it with their mind's eye, never caught the meaning of the thing, and never understood just what it is and does and means in the lives of all of us on this American continent. A curious sort of blind spot afflicts us toward things to which we are accustomed. We see them around us with our physical eye, but those that were here before we were, we are pretty likely to take as a matter of course—to take them for granted as we take water and air and other indispensables of life.

Really, when the railroad was born, there came into the world something totally new; not just a new way of doing things, but a new thing itself. There had been wheeled transportation long before there were railroads, of course, as far back as the history of the race runs. There had been tracks before there were railroads in the modern sense, before we began to use mechanical power on them. And there even had been mechanical power for nearly a century before we had railroads, but it was stationary mechanical power. Combine those three things—trains of cars, mechanical power, and tracks—into one operation, though, and you have created something so totally different from anything that ever existed in the world before that it remade the world.

The dramatic thing about a railroad is power—the locomotive. The essential thing is rails—the rails that guide the flanged wheels of long trains of cars, that make it possible for a hundred thousand or more freight cars to be loaded today and every day in the year at any one of the million and more track locations in the United States and Canada and Mexico, assembled into trains, and moved to destination for unloading at any other one of the track locations on this continent.

### RAILROADS AND OUR NATIONAL LIFE

This combination of the flexibility and convenience of the individually loaded and unloaded freight car with the economy of mass transportation in trains between stations is the fundamental thing about railroads. It is the thing that has made possible the settlement and civilization of this continent—to the extent that it is civilized.

In England you can't get 75 miles from deep water. In the western parts of the United States, you can draw a circle 1,200 miles across that will nowhere touch water deep enough to float a boat, or water than can be made deep enough to float a boat, even with the most generous expenditure of government monies.

Our lives here have been built upon the fundamental fact of mass transportation in trains on tracks. It is a thing that could be done nowhere else, because on no other surface that can be conceived is it possible to have 50 or 100 cars follow at high speed behind one unit of motive power. Nowhere else can you even imagine that being done—although in some of the western states some truck operators seem to have ambitions in that direction.

The situation in the United States today causes us all to focus our thinking pretty much along one line: how we can get on with our belated but so necessary program of preparedness. The question which is asked of us in the railroads—the very fact that it is asked shows the degree of interest that the public is taking in it—is, what the part of railroads will be in such a program, and how ready are they to play that part?

Statistics are necessary to modern study, and the slide rule is a wonderful instrument. But even the most expert and ingenious statistician and the smoothest slipstick operator must get all his facts on the stick and get them on right before he can get the right answer. The easiest way to get the wrong answer is to start with the wrong assumption, to start without the facts. Take the widespread popular impression that the railroads broke down in 1917, and that consequently on the first day of January in 1918 they had to be taken over by the Government because of that breakdown.

### CAUSES OF 1917 DIFFICULTIES

What broke down was not the railroads as transportation machines. The failure that led to that very costly experiment of Government operation during the last World War was not a failure of transportation capacity; it was a failure to use railroads as transportation machines and an attempt to use railroads and their cars as a form of storage for freight that nobody was quite ready to unload.

The best description of what happened that I know of is in the 1918 report of William G. McAdoo, the United States director-general of railroads, outlining the "potent" causes of the congestion that led up to Government operation of the railroads. The interesting thing is that, with one exception, the several points mentioned had nothing to do with railroads. The one exception according to the report, was a shortage of motive power in 1917. There may have been; I don't know and neither does anybody else, because the railroads had no opportunity to use the motive power they had in any proper way.

The significant things are the other causes Mr. McAdoo mentioned. One cause, he said, was the zeal and enthusiasm with which the various departments of the Government issued priority orders for shipment of Government freight. You understand that in time of war the railroads are bound by law to give "preference and priority" to Government freight. Every department of the Government had the right, in the last war, to issue orders that had the effect of putting on the cars little red tags that said, "GOVERNMENT FREIGHT—PRIORITY". And, as Mr. McAdoo explained in his report, not only did every department of the Government have the right to issue those, but there was a keen competition in issuing them, not only between departments but within single departments. He gave an instance: They were going to build the Hog Island shipyard at Philadelphia and they knew that they would need a great deal of piling for that immense project. So they sent zealous young officers through the South where the piling is produced, with instructions to send piling to Philadelphia. And they performed their duties well; they sent piling to Philadelphia. Before anybody needed it or was ready to unload and use it, there were 5,000 carloads of piling standing around Philadelphia.

That was 5,000 cars out of action until somebody got ready to receive them and unload them, which in some cases was months. Not only 5,000 cars, but also precious track room in terminals taken up by those 5,000 cars. They were standing around in one another's way and in the way of everything else that was trying to move.

That is only one example of this practice, which not only went for Government purchases and shipments, but also for contractors who were engaged in the building of ports, camps, shipyards, and other Government projects. It went even for private shippers. It was the practice that if a shipper wanted 3 cars, perhaps he would order 5 from every railroad in town, and he might get 15 or he might not get any.

That sort of failure to recognize the essential nature of the railroad as a moving transportation machine was the great cause of the difficulty in 1917. That is the reason why comparing the railroads today statistically with the railroads of 1917 and 1918 is so misleading. It is true that we have in 1917 and 1918 something more than two and a quarter billion freight cars in this country; and we now have only about a million and three quarters. That is true. It is true also that we had then 70,000-odd locomotives, and now have less than 50,000. But there are some other facts; some of them the intangible facts that don't show in the statistics. Two which do show are that the freight car on the average is considerably larger now than it was then and very much better, and that today's locomotive on the average is more powerful and more efficient. But there are intangibles that can't be expressed statistically: the trains and the cars and the locomotives run on better tracks; they run through better yards, are protected by better signals, and are served by better shops; most important of all, they are handled by better methods than they were 20-odd years ago.

One great mistake caused the comparative failure in 1917. I say "comparative" because, in spite of all the talk, actually nine per cent more freight was handled on the railroads in the United States in 1917 than had ever been handled in one year up until that time. When the Government took over the railroads in 1918, at last there was somebody who could say which priority had priority over all the other priorities. And with that and other improvements, and with all the inherent tremendous increase in cost, the Government was able to move only three per cent more freight in 1918 than the privately owned and separately operated railroads had moved the year before. So 1917 was only a comparative failure, but at that, it was unnecessary. We, all of us, overlooked the essential nature of the railroad as a transportation machine.

That was a mistake that will not be repeated, because all of us—railroads, shippers, and the Government itself—have learned from that and similar experiences, and we have developed, not suddenly but over a period of years, a plan that definitely will eliminate the practice of loading freight into cars in advance of the ability of the receiver to take it and unload it.

#### FORMATION OF SHIPPERS' ADVISORY BOARDS

The year 1922 found the railroads in pretty bad shape, physically. That fall there was a very definite car shortage, the last general car shortage we have seen in these United States. Shippers out in the Northwest, around Minneapolis and St. Paul, were faced with the prospect of leaving the grain on the ground. They realized how much of the difficulty was due to shippers and how much to railroads, and how much to failure to work out a proper working arrangement between them. Voluntarily the shippers in the Northwest got together and formed the first shippers' advisory board. The movement was so successful in meeting a very critical situation in the Northwest that within two years it had spread over all the entire United States. Now there are 13 of these boards, organized on a regional basis. They are composed of traffic managers of industries, the men who actually have charge of moving about 85 or 90 per cent of all the freight that moves.

These boards are not crystal-gazers; they don't claim to be able to tell you what is going to happen next year or the year after next, but four times a year they do get together in each of their regions and from their individual knowledge of what their own individual businesses are going to do in the next three months they put down their estimates of car requirements. These are assembled, and they have been uncannily accurate over a period of 15 years. Also these regional boards make themselves responsible to co-operate with us in meeting any threatened congestion before it develops.

Last fall when the business of this country began to pick up rather sharply, and when, incidentally, there was a great deal of fear that the railroads would not be able to handle the situation, we created a port-control section of our car-service division. That port-control section receives daily reports from all the Atlantic and Gulf ports. It estimates the situation and watches for advance indications of threatened congestion. We don't intend to wait until the congestion develops.

How well this system is working is testified by the fact that few people know that it exists. At the peak of business in October 1939 the railroads handled 55 per cent more freight than in the preceding May. They handled it without the slightest difficulty. In the first six months of this year (1940), they have handled through the Atlantic and the Gulf ports more than 50 per cent increase in export freight as compared with last year. There is moving through the Port of New York now, and has been for nearly a month, more than 80 per cent as much export freight as was moved at the very peak of the World War movement in 1918, and nobody knows it is moving.

The test of this system is that it works. Last year we had to invoke our embargo remedy only once. The grain elevators in New Orleans were full and there were no ships to carry the grain away. Under old conditions we would have continued at the shippers' orders to carry grain to New Orleans and soon we would have had New Orleans blocked. But as we have worked things out in the past 15 to 18 years, we won't do business that way any more. With the full understanding and co-operation of the New Orleans people in charge, the railroads simply issued an embargo against New Orleans on grain. And until there was room made in the elevators, no more grain went to New Orleans. Simple? The plan of not loading freight that cannot be unloaded promptly at destination is so simple that some of our best "planning brains" don't think it is a plan at all.

Our system contemplates no supercontrol; it contemplates no disturbance of the ordinary way of doing things. It contemplates co-operation, and I might add that the proper departments of the Government have co-operated with us and we with them for 15 years on this, and that the Government itself, in its preparedness program or any other emergency which hereafter may come, is going to work right along with the railroads in keeping goods moving just as in the ordinary course of business. We know and they know and anyone who is close to the facts knows that the finest of all traffic control is not a superboard sitting at Washington. As smart as we human beings are and as full of statistics as we are, there is nobody yet who is smart enough to sit in Washington, or anywhere else short of Heaven, and plan out all the movements of all the freight in these 100,000 and more different cars that are shipped every day in the United States.

The best traffic control that ever has been devised is the control of the ordinary shipper about his own business, provided—and this is the one thing which we intend to provide—that nobody is allowed to load freight to an industry, port, or project of any sort, unless the receiver is ready to take it out of the cars promptly upon arrival and release the equipment for other service. Do that and it will insure that these essential channels of communication will be kept open and that we shall not have the difficulties in railroad transportation that we had in the time of the first World War.

Car supply is the thing that people talk most about, but car supply is relatively a minor factor in the whole operation of transportation. I already have said that we have fewer cars than we had in 1918, and yet in eight consecutive years since 1918 the railroads have handled more business than they did that year—as much, in some years, as seven and eight million cars more business, and done this with fewer cars and fewer engines. That largely was because during the 1920s the railroads spent about eight or nine billion dollars for additions and betterments. We largely rebuilt and modernized the railroad plant. The total size of the plant, as measured in mileage of line, is shrinking, but as measured in miles of track it has increased in size. Since the war period, the proportion of additional main tracks, yard tracks, and all other additional tracks has gone from a little more than one-half mile of auxiliary tracks for each mile of single main line, up to approximately two-thirds of a mile. The whole plant and operation have been made better. We built into the railroads the inherent and fundamental efficiency and capacity that are needed, and those are the things that take time, as you all know from your engineering experience. A realignment, a grade crossing, a new bridge, or anything of that sort can't be used until it is finished. Car supply, however, can be increased quickly and relatively easily. New cars are fed into the car supply as they come along. The improvements that take the most time and money already have been made to a large extent. Of course, there are still improvements that could be made, but so far as the capacity of the plant is concerned we have more fundamental capacity than we are likely ever to be called upon to use.

From people who see only half the picture, I have heard criticism of the railroads for having spent the money they did to improve the plant. The theory behind that view is that the railroad business in the 1920s was a dying or at least shrinking business and that the railroads were foolish to spend eight or nine billions of dollars to improve their plant.

### RESULTS OF RAILROAD IMPROVEMENTS

The only answer to that again is the test of the results. In the year 1921 the operating expense of hauling a ton of freight 1,000 miles on the railroad averaged $10.78. In 1938, with both wages and taxes higher than they were in 1921 and with no material savings in the cost of materials and supplies, the operating cost of producing a 1,000-ton-mile of transportation on the railroads was down to around $6.50. That is the result, almost entirely, of the investment in better plant and the improved methods which that better plant has made possible. It is the gains which that improved plant and equipment have made possible which have kept the railroads ahead of the sheriff, in so far as they have stayed ahead of the sheriff, for the last ten years. Of course the sheriff has been right hot after us and he has caught up with nearly a third of us, although I must say that railroads have no monopoly on bankruptcy, particularly in depression times.

The one thing that gives all of us concern about the railroad-future is the fact that for the last ten years railroads, by and large, have not played their part as profit-makers in our so-called profit system—which more properly could be called our profit-and-loss system. And so we hear much talk about the railroad problem, and many remedies

prescribed for the railroad problem. But the problem is not a railroad problem. It is a public problem of transportation, and the difficulty about so many of the proposed remedies is that they overlook that fact.

### A TYPICAL RAILROAD STORY

Perhaps I can illustrate the situation by telling the story of one small railroad, which in its essence is typical of the history of the railroads in the United States. Because it is a small railroad and because it is conspicuous and because its history can be telescoped into one lifetime instead of spread over a century, to me at least it is easier to see.

Once upon a time there was a man. Everything starts with a man, you know—a common two-legged man. This man was rather richly endowed with gifts; he had courage and creative imagination; he had capital and he had credit. It takes all of those to build a railroad. In front of him there was a wilderness; a wilderness of sand and palmetto scrub and alligators and Seminole Indians and not much else. This man took his talents and he built a railroad down through that wilderness. He took the world to the wilderness, and he took the products of the wilderness to the world. The wilderness became the east coast of Florida, one of the phenomena of our civilization. It blossomed and it bloomed, and, in fact, it boomed. The railroad had to add another track and a lot of capacity and equipment to take care of the needs of the traffic. Even today in these depressed years, during the peak season of the year, all that capacity and that extra track still is needed.

About the time the railroad got itself ready to meet the needs of a great business, the boom collapsed as booms will do. So the people decided to use their public tax resources to provide so-called "cheap transportation"—called cheap because the bulk of the cost is concealed in the public taxes. So down on the east side of that railroad, paralleling it from one end to the other, they built a canal and at the important points they built fine artificial and semi-artificial harbors. The canal was for the free use of anyone who was so fortunate as to be in a position to use it and there was much talk about the "savings to the shippers," but nothing was said about the cost to the taxpayers which was considerably more than the supposed saving to the shippers.

On the other side of the railroad they used public taxes to build a fine motorway, open not only to the ordinary automobilist on his ordinary affairs but equally open to those who do on the highways the same sort of business which the railroad does on tracks. The roadway was not offered as a free gift as the canal was. Some charge is made for the use of it and one can get into a great argument as to whether the charge is adequate or not.

Then over the top of that railroad they built an airway. Air is free, but radio beams and beacons and municipal airports are not free, except to those who use them—not for the taxpayers. The only place in which public tax resources could have been used to create a publicly financed and tax-supported form of transportation parallel to and in competition with that railroad that has not yet been tried is underneath. Nobody yet has dug a subway under it.

The railroad went into receivership. And why shouldn't it have gone into receivership? What form of business could be expected to meet the competition of its own Government and its own taxes under conditions of that sort and not go into receivership? The fact that railroads as a whole haven't gone into receivership is the astonishing thing. It is a testimony of the inherent strength and efficiency of the rail method of doing business.

More money has been spent out of public tax resources for so-called cheap transportation in the last 20 years than was spent on the railroads in 110 years. There is more public tax money in transportation facilities now than there is private investment. Most of the private investment—speaking now of fixed plant—is, of course, in the railroads.

More than 98 per cent of all the investment in railroads in the United States is private money. So much is heard about "land grants" that one might think land grants had built all the railroads that ever were built. Actually, less than 8 per cent of the mileage in the United States was built with the aid of Federal land grants. If you take the cumulative total of every conceivable form of public aid to railroad transportation that has ever been granted in 110 years, you will find that more than 98 per cent of the money that has gone into railroads has come out of the pockets of private investors—people like us—out of our savings and insurance policies and the like. That is not true of the fixed plant of other forms of transportation. We embark upon other projects of transportation, financed by what might be called involuntary investment of tax monies, with a blind indifference as to whether or not they are actually economically justified, because they don't have to pay their way.

### "CHEAP WATER TRANSPORTATION"

Do you think that if we stopped for a moment to think of true economic justification we would build all these rivers we build over in the Mississippi Valley and elsewhere in the United States? Did you ever stop to think what it costs to build a river for navigation?

The New York Barge Canal, for example, was worth while once upon a time. It was a fine way of transportation, although even when it was built if they had listened to old John Stevens they would have built a railroad instead and everybody would have been better off; but they built a canal and it was useful to a degree. Of course there came the time when the railroad was built and the canal was not of much more use. It was never of any use in the winter time except to skate on. For a long time the railroad paralleling the canal was required by the State to pay on the freight it handled the same tolls that would have been paid had that freight been moved on the canal.

Then the time came when nobody would use the canal at all and pay for it. There is a curious superstition and popular belief that there is something in the Constitution of the United States that says that people who use inland waterways don't have to pay tolls. There is no such provision, however, either expressed or implied. There was a time when tolls were charged on most, if not all, improved inland waterways and the people who wanted to use them

were glad to pay the toll because that was the best form of transportation then available. But as was the case with the old Erie Canal, the time came when people no longer would use it unless they could use it free. So it was made free. And they wouldn't use it even then unless it was improved. So, beginning in 1903, the taxpayers undertook to improve the canal. They are still working on it. I don't know what that canal has cost; nobody knows because they didn't have original cost and depreciation accounting in the early days, but we do know what it has cost since 1903. Leaving out all the interest costs and maintenance costs and the like, the straight construction cost on that canal up until now is $357,000 per mile. The average annual maintenance cost exceeds $5,000 per mile per year. The freight-carrying capacity of the facility built at such expense and maintained and operated at such expense is only a small fraction of that of a good single-track railroad. And we call that "cheap water transportation"!

"Oh," you say, "That's a canal." And you ask, "What about the great natural inland waterways"? What natural inland waterways? There aren't any. There were once; Indians in canoes could go up and down the creeks and through the rivers and they didn't mind the sand bars. And the old shallow-draft stern-wheel steamboat could fight its way up and down the rivers and did a grand job that was worth while doing in its time. But the modern nine-foot inland-waterway barge has to have a built channel, and those channels cost money. The Ohio River, which is the best of the long-distance projects of that sort, has cost $142,000 a mile to build; and those miles are not measured on any straight-line distance, but are measured as the river winds. And it is costing about $4,000 per mile per year to maintain and to operate. To get that on a basis comparable with rail cost, you would have to add about 50 per cent to take care of the circuity, so we'll say $200,000 per mile is what it has cost to build. That compares with an average cost of about $62,000 per mile of railroad line, excluding buildings—just the track, bridges, and track structure. So a mile of the Ohio River cost three and a fraction times as much to build as the equivalent railroad mile. The average maintenance on a railroad in the United States is in the neighborhood of $1,700 or $1,800 per mile. The river costs nearly three times as much per mile to maintain. "Cheap water transportation!" And that's the best.

On the Missouri River up to Kansas City $198,000 per meandering Missouri mile was spent. And now $238,000 per mile and more is being spent upstream from Kansas City as far as Sioux City. The worst of these things is that they spread. Immediately a channel is built for one city, some other city says, "I must have a channel also to equalize the situation." The upper Mississippi channel has cost $228,000 per mile to build up to last year's report and it is only 81 per cent complete. I don't know what it will finally cost. The Illinois waterway has cost $170,000 and more a mile, and so it goes right through the list.

If people ever stopped to think what such projects mean in terms of actual transportation cost, I doubt if even the local businessmen's organizations would be for them.

What's the answer? Everybody knows that something must be done about the transportation problem. Most people talk about doing something to, for, or about the railroads; but nothing you are going to do to, for, or about the railroads alone is going to answer the problem.

The basic requirement for truly economical transportation in the United States is obvious although not easy to accomplish. That is to put all forms of transportation on the same footing. Put them all on the same level under the law. Let them all meet all of their own costs. Then naturally and necessarily each form of transportation will do the work it is inherently best fitted to do, and will do it at the lowest true cost. It would be foolish to talk about the railroads doing *all* the business of transportation in this country. They never did do it all. There were horses and wagons before there were railroads, and there have been horses and wagons ever since, and there are still going to be horses and wagons. Trucks can do some things better than railroads can. Boats can do some things better than railroads. Airplanes can do a few things better than railroads. For that matter, wheelbarrows can do lots of things better than any one of them.

In fact, I think the wheelbarrow is being sadly neglected in this modern time. I read an advertisement not long ago which appeared in some North Carolina newspapers. It was an advertisement by a group of trucking companies urging people to patronize trucking lines on the ground, among others, of providing great relief to unemployment problems because it took the services of ten times as many men to haul a ton of freight a mile on trucks as on the railroads. And that is about the correct proportion. But if we are going to look on our transportation from the point of view of relieving unemployment by increasing transportation costs, let's be consistent and go on back to the good old wheelbarrow. Then everybody would have a job. He wouldn't have much in his stomach while he was working and he wouldn't have much for clothes on his back and he wouldn't have much of a house to live in, but he'd have a job pushing a wheelbarrow.

That's almost the condition that prevailed in the world in the days before mass transportation by rail. So much of the labor of the human race went into the job of a little piddling transportation of a little shirttail full of this and that for short distances that there was but little capacity to produce. Even if there had been the great productive machinery now so common, it couldn't have been operated, because the raw materials could not have been assembled and the products couldn't have been distributed. The thing which has made possible the world as we know it is the fact that mass transportation in trains on tracks has released human energy to produce, and has made available to that human energy the resources of continents lost to man beforehand.

The thing to do, it seems to me, for a machine which has proved itself able to do that, and which is still doing it and doing it on a basis of true cost far lower than any other form of transportation, is to give that machine a fair and equal chance to do the thing it can do best. That will not be all the transportation, but it will be the movement of the great mass of the major commerce of this

continent. This should apply not only to the railroads, but to every form of transportation. We should set up such conditions of equality that each naturally would do its own job and not be digging around into the job of the others. Then, we'll have the best transportation we ever saw, and the cheapest. That is what everyone really wants.

## The Case for Government Ownership

WILLIAM J. WILGUS

Former vice-president and chief engineer, New York Central Railroad

Before presenting a point of view which I fear may be shocking to some, I should like to mention a point made by my adversary. That was the reduction in costs per unit in transportation by rail. This has been and is marvelous, but we must not forget that the eight billions that were expended in order to bring that happy result have brought to the poor investors one-half of what they earned before the money was invested. And the cost to the transporter has gone up from $0.007 to $0.01 per ton-mile. So there is another side to this case which I hope you will bear in mind.

We are, of course, living in tragic times. As we look backward we realize that our forefathers 165 years ago were living in tragic times in facing the mother country in order that we might gain our independence. And some fourscore years later our fathers and grandfathers faced a similar situation when they had to put their shoulders to the wheel to hold together the Union which had been created as a result of the War of the Revolution. Then came the World War, in which we took our part in order to protect what we then believed in, the freedom of the seas. And now we have come down to these days, which to me and I think to you, are far more complex than those earlier times, because we have to cope with our internal economic difficulties as well as the protection of our fair land against attack from abroad in this world in flames.

Bearing those things in mind, we realize if we give thought to it that transportation is in a way the primary instrument in our social order to which we must look in solving these problems which, to the popular eye, are the outstanding ones. In some 55 years in the field of transportation, I passed through several periods of depression. The greater prior to this one, in the 1890s, brought to my attention the need for solving the rehabilitation of one of our great systems which had fallen into decay because of starved maintenance and improvement during that period. As to military needs in transportation, for nearly two years I had to do with the laying of foundations for the army transport system in France, and grew to realize that conditions are entirely different in times of war from those in times of peace in their drafts upon that organ we term transportation. Unless we have passed through the experience we cannot judge from the results in time of peace what we must cope with in time of war.

The facts that I shall lay before you will, in my judgment, lead you logically though reluctantly to the conclusion that the private ownership of our financially stricken disunited railroads is doomed. And with that admitted, you will, it seems to me, reach the further conclusion that upon their amalgamation into a harmonious whole under Federal auspices, their pressing needs for rehabilitation and improvement may be met and some form of co-ordination with their rivals in transportation brought about, all in the public interest.

We shrink, of course, from this further governmental invasion into the field of private enterprise, but in these days of peril we may no longer temporize with a situation fraught with danger. If private enterprise serving an urgent public need cannot finance its necessities, Federal intervention is the only recourse. Society, after all, depends for its very existence on travel and trade, and equally so on the movement of men and munitions for national defense. To the extent that the means of serving these purposes are faulty, to just that extent will our society suffer; aye, perhaps go under as have other civilizations in the distant past.

Transportation, then, is in all truth a social problem. As never before does it behoove us to take stock of our resources, so that without further loss of time we may be prepared against such fatal consequences as we are witnessing from day to day on the other side.

When we look backward over our national life span of 150 years, we see how man and animal power and the sail gave way to the steamboat, followed in succession by the steam locomotive, the electric motor and pipeline in certain instances, and finally the internal-combustion engine. Out of this Topsy-like growth has emerged a system of transportation in which chaos reigns, each of its five types at war with the others and within itself.

### RAILROADS OF OUTSTANDING IMPORTANCE

Of these types—railroads, highways, waterways, pipelines, and airways—the first named, though sadly stricken in recent years through the diversion of competitive traffic to its rivals, still remains the backbone of our transportation machine and promises so to remain indefinitely so far as we can read the future. It is dependable in all kinds of weather—winter and summer, fall and spring. It reaches every nook and cranny in the land by continuous routes carrying freight in interchangeable equipment under uniform rules and regulations and joint through rates. It is adapted to speedy mass movements of persons and of property of widely differing weights and bulk. It is in brief a closely interwoven network of interdependent links united physically though disunited in a managerial and financial sense. None of its rivals can meet these conditions in full. In a national emergency it is vital for the swift dispatch of troops from all over the land to cantonments and thence to their objectives; and of the innumerable products of soil and forest and mine to mill and factory, and thence to storehouses, shipyards, ports, and scenes of conflict. Over its rails must move big-caliber naval guns on wheels for coastal defense and for distant bombardments of enemy centers; also guns and armor and machinery for battleships as well as modern engines of warfare such as mammoth tanks, all too heavy and too bulky for highway and air transport and too urgently required

on the minute for the winter interruptions, uncertainties, and long delays of internal movements by water.

### RESULTS OF THE DEPRESSION

It is natural at this point to ask to what extent the railroads as a whole have suffered from the effects of the past ten-year depression. For an answer we have but to turn to the authoritative *Railway Age* of January 7, 1939, to learn that the results have been deplorable. Not only have items of equipment fallen off in great number, but what remain are to a large extent outmoded and over-age. Forty-five per cent of the cars are reported to be more than 20 years old and 70 per cent of the locomotives over 19 years old, both spelling inefficiency and costly upkeep. They call for replacement on a gigantic scale, in which shall be embodied advancements in efficiency, adaptation, comfort, and attractiveness in the public eye. Terminal and port facilities in many cases call for modernizing; bridges and masonry for repair and strengthening; embankments and cuts for widening, riprap protection, and drainage; level crossings for separations of grade; gradients and curves for reduction and straightening respectively. Main lines call for multiple tracking; sidings for lengthening; water and fuel stations for betterment and expansion; shop tools and work equipment for replacement and betterment. Centers of congestion call for bypasses; station buildings and right of way for freshening in the interest of good appearance. Rail, ties, and ballast call for renewal and betterment; signals and interlocking for extended use in the interest of safety and expedition; and other parts of the railroad machine as a whole, after so many years of neglect, likewise call for rehabilitation and improvement.

### FINANCIAL NEEDS

It has been asserted by representatives of the Association of American Railroads that the picture is not as black as thus painted because the falling off in traffic during the past 10 years has resulted in a letup on wear and tear. This claim fails to give weight to the well-known deteriorative effect of rot and rust and frost and storm, and to obsolescence and inadequacy, all of which in the aggregate cause depreciation regardless of use. Generally it has been considered that two-thirds of the expense of maintenance is chargeable to the passage of time. If we compare the average annual outlays for maintenance prior and subsequent to 1929 we find that their decrease since that date, fairly assignable to the passage of time on a half-and-half instead of a two-thirds basis, amounts to more than a half-billion dollars per annum. A similar comparison of the sums annually devoted to improvements before and after 1929 shows a shortage of about the same amount. A combination of the two approximates $1,000,000,000 a year; a figure that coincides with that given in the issue of the *Railway Age* to which I have referred. That authority, quoting the words of the President's "committee of six" and the vice-president and general counsel of the Association of American Railroads, considers that that annual sum should be expended for several years in order that the railroads as a whole shall regain lost ground and meet the demands of the hour. For a period of 5 years, therefore, the railroads by and large should have poured into them some $5,000,000,000, a figure that is but slightly in excess of that given for improvements only by our fellow engineer, Ralph Budd, president of the Chicago, Burlington, and Quincy Railroad and now a member of the recently appointed Committee on National Defense.

I may perhaps be pardoned for adding a page from my own past experience in the rehabilitation and improvement of one of the principal systems of the country following the depression of the 1890s. Its main route traversed by crack trains gave no outward indication of grave defects that lurked beneath, nor of bad conditions on the side lines and branches and in terminals not visible to the principal officers and influential travelers who seldom if ever viewed them. Safety everywhere on the system was at stake; and the reasonable convenience and comfort of passengers whether they were carried in luxurious state on the main stem or in a humbler way in vastly greater numbers on the lesser routes. From my observations of today I feel that the same remarks are in order if our railroads in some degree are to win back their old prestige.

In a word, what is needed is an added investment in our railroads approximating $5,000,000,000 in order that they may meet their social obligations with satisfaction to their patrons of high and low degree and, above all else, faultlessly back the Army and Navy in our hour of trial.

### VANISHED CREDIT

How is this enormous sum to be raised? Certainly not from private sources unbacked by the Government. The railroads' share of the total national income since 1919 has been steadily downward in good times and bad. Their average revenue per ton-mile since 1916, in an effort to make up for their striking losses in passenger revenue, has been maintained at a far higher level than the price level of the commodities they carry, thereby driving their shippers into the arms of their rivals. Their net operating income since 1916 has dropped something like a half, though some $8,000,000,000 have been poured into the enterprise. Two-thirds of their mileage is in the courts or on the ragged edge of insolvency. Their bonds in large part have been removed by the State of New York from its list of permissible savings-bank and trust-fund investments. Their stocks—that is, their venture capital—are with rare exceptions unsaleable, although essential in private enterprise as a cushion for the protection of the funded debt. Their consolidation into a limited number of systems, with the accompanying scaling down of their securities to modest limits, has no promise of accomplishment in the reasonably near future. Briefly, the credit of the railroads as a whole has vanished. Their only recourse is Government aid which at present is extended to them on a comparatively small scale, and in reality is a backdoor entrance to complete control without responsibility for the outcome.

### GLOOMY PROSPECTS

It will be said, no doubt, that the present upsurge of war traffic points to the coming of better days. But

surely this cannot be viewed as a permanent or for that matter a temporary solution. The aftermath of war, as proved by history, will be quite the other way. Even as it is the railroads in large part are still in the depths of despond. During the first quarter of this year more than one-half of the RFC-selected Class I railroads in the New England and eastern regions failed to earn their fixed charges, one-third in the southern region, 90 per cent in the northwestern region, three-quarters in the central western region, and nearly a half in the southwestern region. Only in the Pocahontas region were fixed charges earned in full by all three roads. In the aggregate, 44 out of the 81 railroads fell by the wayside and of these 11 did not even earn their operating expenses and taxes! On top of this it is to be expected that taxes and costs of materials as a result of our measures for defense will go up, while freight rates will remain stationary or continue downward. In light of the past and present, and of what is ahead of us in a world of turmoil, we must not rest our fate as a nation on wishful thinking. The money required to put the railroads on their feet is as much needed right now as are the billions of new money at present being appropriated for our other means of national defense. We cannot for our nation's safety afford to rest its fate on a hoped-for railroad comeback not now in sight.

### A FEDERAL RAILWAY AUTHORITY

By many this additional call for funds on such a scale will have an ominous sound. But rightly handled it is not to be feared. Taken over by a Federal Railway Authority in return for its low-interest-rate securities, the railroads as a whole should not cost more than 50 per cent in excess of their market value of some $10,000,000,000 as of a year ago, or say $15,000,000,000 in all. The actual annual net operating income during the past 10 years has averaged enough to support an investment of $20,000,000,000 at the Government's present low rate of interest. The difference, $5,000,000,000, raised through the sale of the Authority's securities, would pay for the needed rehabilitation and improvements. In addition the money thus released from the country's frozen resources would relieve our WPA rolls and inject new life into the arteries and veins of many of our moribund industries.

Time now being of the essence, the railroads under this plan would be taken over at the stroke of the bell, as they were at the beginning of 1918, on the basis of a fair annual rental as was done at that time, pending the determination of their fair value in courts to be set up for the purpose. With this would go a form of co-operative management, free from politics, in which the five interests involved—executives, labor, shippers, investors, and the public-at-large—would take their part. In this connection I venture to direct your attention for details to an article from my pen in the October 1939 issue of *Civil Engineering*, where I endeavored to show that this could be handled without politics.

There are several reasons why no time should be lost in bringing this about. Our equipment plants and steel mills will have no room for railroad needs if they are to become loaded to the limit of their capacity with orders for munitions at home and abroad. Lines in whole or part incapable of earning a commercial return, like the Ontario and Western, Rutland, Old Colony, Long Island, Norfolk and Southern, Chicago and Northwestern, Omaha, Alton, and Minneapolis and St. Louis railroads, may be abandoned in whole or part if not rescued for national defense. After all a main line or branch essential in an emergency for the transport of troops and supplies, or gun-mounts or tanks, should not be expected necessarily to earn its way, any more than the battleship or army is expected to yield a money return. Again, a speedy survey of the railroad situation in qualified hands should determine not only what rehabilitation and improvements should be undertaken in their proper order, and the estimated cost of so doing, and what lines should be retained from the angle of defense regardless of their earning power, but also what lines with propriety really should be abandoned so as to obviate expenditures upon them, as for instance for the elimination of grade crossings, which would be thrown away.

### CO-ORDINATION A NECESSITY

With the making of the railroad survey of which I have made mention should go similar action in the other types of transportation, not with the idea that they should be taken over by the Government, but to determine their scope and nature, and the extent to which public regulation should be instituted in the interest of all; also to inaugurate an organization whereby their activities and those of the nation's railroad system may be co-ordinated somewhat as I have indicated in the *Civil Engineering* article to which I have previously referred.

I have endeavored to express my deep conviction that transportation in the United States is a social problem of the first magnitude that must be wisely solved, and that, too, without further loss of time, if the country is to be put in readiness for defense. Others may have a different solution than mine. If so, I pray that they may speak up convincingly. Whatever it may be I venture the belief that it should be founded on the principle that "united we stand; divided we fall". A disunited system of railways will no more succeed in its aim to protect the interests of the nation, than did our confederation of states politically before we became the United States. The Association of American Railroads, as now constituted, is without power to enforce its decrees. Its members very naturally have first to serve their individual interests not those of the system as a whole. No temporizing will cure this defect. Co-operative management under Federal auspices will, as I see it, accomplish that end, and in co-ordination with the other means of transportation cement all of them together for the nation's good.

To repeat then, if the solution I have proposed is deemed to be faulty, what is the alternative that will loosen the country's funds so that they will flow instanter into the field of transportation?

### MISCONCEPTION OF WAR NEEDS

Colonel Henry has discussed the quickened movement of trains and cars in recent years. But this will not make up

in war time for the railroads' lessened volume of equipment. Needs for cars and locomotives in areas of conflict—theaters of operation, as they are called—are likely to be very heavy. For these the home railways will have to yield of their stock on hand. In France during the World War we had on demand upwards of 5,000 locomotives and 100,000 cars. Allies, too, on this hemisphere or elsewhere will look to us for aid in this particular. The exigencies of war cause upsets in regular schedules with resultant lessening of the efficiency usual in peace time. Solid trains of empty cars, without awaiting loads, often must be sent long distances for urgently needed materials. I say in that connection, suppose our Panama Canal were put out of commission. Railroads would have to come to the rescue. Interruptions or curtailments in our intercoastal or other coastwise water traffic would throw a greatly increased burden on our rails. Loaded cars will be held immobile at ports when shipping may be held up by ice or unanticipated war conditions. Losses in the field will reduce the available stock of cars and locomotives. Trained personnel must be drawn upon for the operation of military railroads, leaving untrained men to take their places with an unavoidable loss of efficiency in train and car movements. Friction resulting from enforced diversions of traffic from one road to another, such as occurred in the World War, will have baneful consequences. I speak of these from personal knowledge. No greater mistake can be made than to close the eye to these conditions, to deny experience, and to invite a breakdown of our transportation machine at some critical moment in our affairs.

### A CALL TO ACTION

After all, it is to our means of intercourse that we must look for the preservation of our civilization, for the continuance of the institutions we hold dear. Doubly is this true in these days of peril when we must be prepared, and that quickly, to back our Army and Navy to the limit. Neglect in this, especially in a land so broad as ours, may well lose to us their fight in our defense, as have the shortages in tanks and airplanes brought defeat to the Allies across the sea. Financially and physically must we speedily put in perfect order our railroads, the backbone of our transportation, and unite them for one common purpose—the welfare and safety of the people of the United States.

In calling for that action, it seems to me organization and leadership must come first. In round figures we have 80-odd independent Class I railroad systems. In other words, we have 80-odd generals, with no commander-in-chief who can impose his will upon them as Foch did upon the Allied armies during the World War. Then, what is even worse, we now have supervising them six independent agencies with a promise of a seventh. There are the Quartermaster Corps and the Corps of Engineers of the United States Army. Also, we have the Interstate Commerce Commission which, as stated in the provisions of law which were quoted in its report to Congress on November 1, 1939, has the right to exercise managerial powers. Then we have the Association of American Railroads filling a very fine purpose without executive force, without the power to enforce its decrees. Then we have the so-called Owen D. Young committee which is for the purpose of investigating over a period of unknown time, perhaps a year or two, and then bringing in some kind of a report, as to which there may or may not be unanimity of approval. Then we have the Council for National Defense with its branch devoted to railroads under Mr. Budd. Just how he can function in harmony with the American Association of Railroads and with these 80-odd different railroads so far as I know is unknown. And then we have the possible transportation board to be organized under the provisions of the Wheeler-Lee bill that so far has not had Congressional action. Should that be passed, you have seven of these different agencies, all milling around without any single leadership to bring them together and have the railroads work together as a unit.

You may say, "Why is it necessary for them to work together as a unit?" We have the weak and the strong. The weak are just as essential to the functioning of this network as a weak link is to the strength of a chain. The strength of a chain is measured by its weakest link; so is that of our network. We have such railroads as the Chicago and Northwestern, Ontario and Western, Rutland, Long Island, Alton, Soo, Denver and Rio Grande, and Norfolk and Southern tottering. Twenty-five out of 133 Class I railroads failed to earn their expenses and taxes in the first six months of this year; 48 out of 81 failed to earn their fixed charges during the first five months. Their failure means the entire network is in danger. As I see it, that lack of leadership, that lack of solidarity, that very lack of the principle that has made our 48 states a Union is what now demands a cure.

(*Editor's Note:* Following Colonel Wilgus' address, the meeting was opened to discussion, and Colonel Henry was offered the opportunity of presenting a "rebuttal." The substance of his additional remarks follows.)

## Further Defense of the Railroads

ROBERT S. HENRY

Colonel Wilgus' statement that the average charge to shippers, as measured by the average revenue for hauling a ton of freight a mile on the railroads, has gone up from \$0.007 to \$0.01, is true if you take a sufficient length of time and ignore the intermediate period. The seven-mill rate prevailed before the first World War. A great many things have changed since that time. For example, back when seven mills was the average charge per ton per mile for handling freight, the railroads were paying to government for taxes approximately two cents out of each dollar of revenue taken in. Last year the railroads paid in taxes just under ten cents out of each dollar taken in. In the days when railroads were handling freight at seven mills per ton per mile, the wages of engineers, conductors, and all other labor were less than half of what they are now. My recollection is that the average railroad wage in that

period was 20-odd cents an hour. Today it is 75 cents an hour.

Now in between that time and today was the period of the World War. At the conclusion of the World War period the average revenue for hauling a ton of freight a mile in the United States was $0.01275. Last year it was $0.00985. That comparison gives a measure of the improvement and of the decrease in charge which has kept pace with decrease in cost in those years.

For his description of the rather parlous state of the railroads Colonel Wilgus relied rather heavily upon the statements of *Railway Age* of January 1939. In May 1939, President Roosevelt, through Secretary Morgenthau, asked two very eminent railroad men, Mr. Willard of the Baltimore and Ohio and the late Mr. Carl Gray of the Union Pacific, to give him a report as to what the situation would be on the railroads in an emergency. They made a report in May 1939, which at that time was confidential, in which they said that with the condition of the railroad equipment as it was then the roads could handle an increase of 25 per cent above the tonnage they were then handling, and that by putting the equipment into full repair, the roads could handle 45 per cent more.

At the beginning of September 1939 war broke out in Europe. On the same day appeared the *Railway Age*, which is an authority and a very ably edited paper, but is not, as is sometimes thought, an organ of the railroad industry; it is a trade paper concerned with both the railroad industry and the railroad-supply industry. The *Railway Age* printed elaborate statistical calculations to prove that the railroads would absolutely break down under the load in the fall of 1939.

That was September 1, 1939. Then what happened? In October 1939 railroads in the United States handled not 45 but 55 per cent more freight than they had been handling in May. They handled it without any car shortage, congestion, delay, or difficulty. And the repair program to which I referred had not been put fully into effect.

Now what is the condition today? The first of June 1940, there were 36,000 or 37,000 more serviceable freight cars in operation in the United States than there were on the first day of October 1939. And remember that in 1939 the railroads handled whatever was offered, which was a good deal more than anybody had anticipated, and handled it without difficulty.

So far as the war load is concerned, the railroads do not anticipate any tremendous increase. Of course the operating difficulties which Colonel Wilgus mentioned no doubt will develop, particularly if war should come to the American continent. But as for the preparedness program and the tonnage to be anticipated at any time in the near future, there is no reason to expect any such increase as is commonly referred to. The war load in the United States in 1918, as nearly as can be determined from the studies we have been able to make, was only a 12 per cent increase above the previously prevailing level. Last year the railroads picked up a 55 per cent increase in four or five months without serious difficulty.

That is not to say that the railroads are just as we should like to have them. Very few of us connected with industries find things as nice as we should like to have them; very few of us have the plant that we should like to have. Of course further improvements will be made in the railroads. There always have been. They are made more rapidly in good times and more slowly in poor times, but the process does not stop. So far as this idea that the railroads are staggering in a decrepit and broken-down condition is concerned, let me cite you a few facts.

The railroads spend less money per mile on track maintenance than they did before 1929, a great deal less. And never again will they spend as much per mile for maintenance as was spent before 1929, because it isn't necessary. Twenty years ago less than half the cross ties in the railroads were creosoted and treated timbers. Now five-sixths or more are treated ties which last three or three and a half times as long as an untreated tie. Twenty years ago when a rail became worn on the ends, it was taken up and relaid in a sideline somewhere. Now when a rail wears on the ends, crews build up that worn end right in place in the track with a welding process and when they get through the rail is practically as good as new, and at a cost much lower than for the earlier practices. Improvements could be made, of course, and they will be made wherever they are economically necessary and economically justified.

But consider the record of what the railroads have done in the last few years in spite of all their difficulties. Take the one element of safety. The accident rate on railroads is now one-fifth of what it was 20 years ago. Your chance of getting hurt on railroads, whether you work on the railroad or ride on it, is one-fifth what it was 20 years ago. The chance of your freight being damaged on a railroad is one-sixth of what it was 20 years ago. And, as Colonel Wilgus has said, we are moving the trains faster. We are getting more than twice as much use out of a freight train as we did 20 years ago. That isn't the record of a "decrepit machine"; that isn't the record of a machine that is creaking at the joints and falling to pieces. That isn't the record of railroads that are stuck together with chewing gum and chicken wire.

So we in the railroad business see no necessity for any tremendous sudden programs of rehabilitation of the plant. If a necessity seriously existed, of course we would have to give serious consideration to it, but the remedy proposed of Government ownership and operation of railroads reminds me of an experience. At an anthropological museum out on the Pacific Coast there is a collection of ancient Peruvian skulls. Some of the skulls have little holes in them which the curator explains as having been caused by the headache remedy which the ancient Peruvians used. When a man had a headache the witch doctors decided that his trouble was a devil inside his skull. So they took their bone knives and scraped a hole in his skull to let the devil out. And they cured the headache.

We have a democracy in the United States and I hope we shall always have it. It is a thing that is worth fighting for. And what is the essence of it? That we are free men; that nobody has complete control over us. The Government has political control, true; the church has spiritual control, maybe; the diverse and diffused economic powers have some economic control. The separation of pow-

ers as between church, state, and economic order is the great achievement of the last 150 years. And the greatest single step to be taken in this country toward what we now call totalitarian government—which in the days of George Washington and the men who wrote the Constitution was called absolute monarchy—would be to concentrate again in one place and under one control both economic and political power over the lives of men. And the greatest single step toward that, as I see it, would be to turn the railroads over to our Government to operate.

That might cure some of the troubles. The Peruvian's headache disappeared—and so did the Peruvian.

Of course I realize that I am not answering what Colonel Wilgus said. He said that he believes—most conscientiously and patriotically, I am sure—that the salvation of our nation depends upon achieving certain effects with our railroads. We of the railroads believe that those effects can be achieved better through the present way of doing things. It is true that there are about 80 separate systems in the country. It is true that there is no absolute control over them except that which the Interstate Commerce Commission could exercise if it thought necessary, but which it has not yet seen fit to apply. But I am not sure that this diversity is entirely a weakness. I am not so sure of the omniscience and the all-pervading abilities of the gentlemen in Washington. I am not so sure but what there is an advantage in having railroad headquarters scattered about all over the United States. I am not so sure but what the competitive spur has produced more than it has cost. That is a question for argument and speculation.

One other thing—there are certain railroads that are necessary in time of defense which are not necessary or even desirable for commercial purposes. By way of comment on that point I shall outline an interesting but little-known fact. In 1869 the Southern Pacific Railroad built a line from Ogden, Utah, around the north end of the Great Salt Lake. Later they built another line over about 30 miles of trestle and bridge across Great Salt Lake. Shortly thereafter, the Western Pacific built a line from Salt Lake City around the southern end of Great Salt Lake. All these ran into the San Francisco Bay area. The old line around the north end of the lake having ceased to be of any real commercial use, about six years ago the Southern Pacific Railroad asked authority from the Interstate Commerce Commission to abandon it. The War Department intervened, among other objectors, pointing out that in case of an emergency in the Pacific the San Francisco Bay area would be vital and that all possible tracks might be needed. Subsequently the Interstate Commerce Commission, whether for that reason or for others, refused to allow the abandonment of the line and it is now being maintained and operated by the Southern Pacific Railroad, as an element in the national defense.

There might be other such situations, and it may be that special adjustments should be made to take care of such things. But that's a totally different thing from handing over the operation of these railroads to the Government of the United States. It is a great Government in its field; but its field is government and not running railroads.

## Magnetic Storms

DURING the great magnetic storm of April 1938 energy was expended at the rate of two billion kilowatts for a two-hour interval. Couched in more comprehensible terms, this is 100 times the capacity of all the hydroelectric developments in the United States and 4 times the estimated potential developments of the entire world. The magnetic storm of March 1939, which produced so much disturbance on power and communication lines, seems to have been greater than the 1938 storm; possibly it is the greatest ever recorded.

A number of generalizations may be drawn from our knowledge of magnetic storms. In the first place, each storm is world-wide. Of course, there are regions where the effects of such storms are more pronounced than at others. In equatorial regions the effects are least violent, while at a distance from 20 to 30 degrees from the geomagnetic poles—the auroral zone—they attain their maximum intensity. One outstanding feature of great magnetic storms is that this auroral zone shifts to lower latitudes.

Mathematical analysis has shown that field changes during magnetic storms are due principally to causes above the earth's surface, presumably electric currents, and that these external effects are accompanied by effects due to the induction of currents within the earth by the primary external fields. The field changes may be divided into two classes—those which are symmetric about the earth's magnetic axis and those which are nonsymmetric. The latter are associated with electric currents flowing with maximum intensity along the auroral zone. Field changes arising from these currents are responsible for the effects on communication and power lines. The strength of the auroral-zone currents may exceed 1,000,000 amperes, and changes exceeding 100,000 amperes in one minute have been observed. Changes of from 10,000 to 15,000 amperes per second would be sufficient to produce electromotive forces of the magnitude required for effects on power lines (about 10 volts per mile).

The cause of the primary electric currents in the outer atmosphere or about the earth remains a matter of speculation. Regardless of the causes of magnetic storms, however, there is nothing scientists or engineers can do to control them. Their effects on power and communication lines can be reduced to inconsequential importance by suitable installations, but the cost of these installations involves economic considerations. Judging the future by the past, great magnetic storms may be expected at the rate of one a decade. Records go further than this: They show that the frequency of magnetic storms of all intensities follows the 11-year sunspot cycle, lagging behind it by about two years. The evidence does not recommend that drastic steps be taken to minimize the effects of magnetic storms on power and communication lines, for it assures that such effects as occurred in March 1939 will rarely be repeated.

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Abstracted from an article of the same title, by A. G. McNish, published in the Edison Electric Institute *Bulletin*, July 1940, pages 361–4, 370.

# A Message From the President

## To Members of the Institute:

THE AIEE has entered upon its 57th year. As usual at this stage of the Institute year a new president is in the chair. He is very happy to be your president and proud of the fact that he is an engineer. In order that you may know how interesting he has found being an electrical engineer and a member of the Institute, he is going to risk criticism for lack of good taste and tell you some of his engineering experiences—not that he would boast of any of them, but rather that he might neutralize some of the pessimism brought about by the discouraging actions of humans. He trusts that his words may cause those members of the profession who have practiced for a time to recall their own happy experiences, and may indicate to the younger members possibilities for happiness which cannot be destroyed even by tyrants lusting for power. He started being an engineer before the days of vacuum tubes and electronics, yea, even before the days of "wireless," by climbing distribution-line poles, fixing primary-battery-powered doorbells, and displacing coal-oil lamps by wiring old houses.

Each phase of his engineering life—lineman, stoker, power station operator, student, testman, designer, teacher, consulting engineer, and what not—has contributed generously to an abundant life and brought many opportunities clamoring at his door. Would that he could have recognized more of those opportunities and let them in!

As long as memory lives he will recall the thrills that came when he conquered a stubborn pair of climbers and learned how to make them take him safely up a pole and down again without accumulating too many splinters; when he learned the little twist of the wrist that spread the coal properly and placed it in just the right place in the firebox; when he learned how to test "on the fly" by a trained sense of touch the condition of moving engine parts and squirt a bit of oil into just the right places to keep the machinery operating smoothly; when he learned to open the throttles properly to bring sleeping engines and their dynamos into activity, and by closing a few switches to send the electric current out over the circuits into homes and places of business; when he conquered a puzzling calculus problem or became aware of the meaning of a sentence in a science textbook; when he was the first to apply power to a newly built transformer or other machine and compare its measured performance with design calculations; when he saw a testman test one of his own designs and find that measured test values showed the design to be correct to specifications; when he saw some fortunate exposition he made open to students a glimpse of how to solve engineering problems and what it means to be an engineer.

He had the capacity to gather only a few fragments of those many opportunities presented to him, but those fragments are burnished bright by memories of friendly assistance on the part of his associates too numerous for him ever to repay. To cap the climax you have made him president. He is experiencing "the thrill of a lifetime," and why not? If he could live his years over again he would choose to be an electrical engineer and a member of the Institute, the official professional society for electrical engineers. As a working member of AIEE he has had a deal of satisfaction in doing his bit for our great organization. As your president he is having the pleasure of taking over the throttle of an efficient, smoothly operating organization. During the past year President Farmer, the board of directors, National Secretary Henline, National Treasurer Slichter, and all the staff have done a good job and turned over to the present administration an Institute in excellent condition with all business completed to date. Indeed, in every way our Institute is on the right track and making good speed ahead.

Your president has no illusion that this sudden honor granted him by the grace of God, favorable chronology, geographic influences, and the activity of friendly professional colleagues in the Institute has brought with it any endowment of new ability to serve properly as your chief officer for the current year. He pledges you, however, that he will do the best he can. We are in for a good year. The members who have been asked to serve on committees and in other capacities have responded with enthusiasm. Papers of interest are being written. Our budget is balanced, and, although less than we would choose, is after all no mean sum which serves quite well the financing of our planned activities.

To all members who have made these things possible your president extends thanks and congratulations. He can wish them no greater joy than to hope that all

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Royal W. Sorensen, President AIEE 1940–41

who have been engineers for some time have found a measure of satisfaction in proportion to their years in the profession equal to that which he has experienced. To those new in the profession he can hold up no reward greater than the wish that they will have an interest in the profession and a joy equal to that which has been his. Moreover, he is certain that the future for engineers holds even more promise than the past. Men such as those who have made the engineering profession will not let America die or let the ideals of her people be trampled in the dust.

To attain such hopes every one of us must work for our profession and through it for our country and its ideals as never before. Engineers need not be told what to do, because professional men have the vision that enables them to discover what should be done as well as the ability to do it.

Our job is to engineer, and that we must not neglect. Through the officers of our Branches, Sections, and Districts, we must continue the work of the Institute. In the present world crisis, engineers must not be satisfied with making a product that is good, but must become active in adapting that product to the special needs of the day—national defense; hence the resolutions pertaining to that subject passed by your board of directors and published in the August issue of Electrical Engineering. Engineers must become more active in having a voice in determining how the world shall use science and engineering. To do this they must enlarge the circle of their activities and, through channels provided by political and other nontechnical organizations, make their proper contributions to human progress. Engineers must insist on the right to equal partnership with other people in all the affairs of men, but in so doing they must not think engineering knowledge alone gives claim to speak on other matters.

As you think over these things keep ever in mind the fact that the Institute is a "co-operative-voluntary organization" which has value directly in proportion to the integrated activity of its members. Thus it becomes not only the privilege of each member but also his duty to take some part in its program. Nothing less will make the Institute all that we would like to have it. Further, only by such active participation can you as individual members realize the full potential value of your membership, for "Whatsoever a man soweth, that shall he also reap."

Royal W. Sorensen

## Middle Eastern District Meeting To Be Held in Cincinnati October 9–11

THE only Institute District meeting to be held during the remainder of 1940 is the Middle Eastern District's meeting, scheduled for October 9–11 in Cincinnati, Ohio. Taking advantage of this fact, the committee responsible for that meeting has extended a special invitation to all Institute members and their families. In support of this invitation, the committee has arranged a program of unusual interest, and has emphasized the fact that Cincinnati is centrally located and convenient of access from all directions. Headquarters will be in the heart of the city, at the Netherland Plaza Hotel where air-conditioned meeting rooms will be available for the technical sessions.

The "Queen City" affords many unusual opportunities for recreation and sightseeing, full advantage of which has been taken in the arrangement of the entertainment and inspection-trips programs. A diversified technical program of topics of timely significance has been provided. The annual business meetings of the District executive committee and of the District committee on student activities will be held. The Student Branch convention will provide students with an attractive program especially devoted to their interests.

### ENTERTAINMENT

A bridge luncheon for women guests is scheduled to be held in the Red Alcove of the headquarters hotel at noon on Wednesday, October 9. That afternoon is reserved for shopping. At 6:30 in the evening there is to be a smoker and buffet dinner in the ballroom of the Hotel Metropole. Evening entertainment for women will be provided at a large radio studio where they may witness the presentation of a national feature program.

Thursday morning, October 10, women guests may visit the new laboratories of the Kroger Food Foundation. In the afternoon they may attend a musicale and tea at the old colonial home of the late Charles Phelps Taft, where famous collections of paintings, French enamels, Italian majolica, and Chinese porcelain will be on display.

Thursday noon a men's luncheon will be held on the Pavilion Caprice Terrace at the Netherland Plaza. The gathering will be addressed by C. T. Sinclair, AIEE vice-president for the Middle Eastern District. In the afternoon an inspection trip is scheduled to the Newport Rolling Mills and Andrews Steel Company, Newport, Ky. Those not interested in this trip may substitute the sightseeing tour around Cincinnati.

In the evening in Pavilion Caprice an informal dinner will be held over which Professor A. M. Wilson of the University of Cincinnati will preside as toastmaster. A feature address is planned.

For Friday, October 11, a special inspection trip through the Ivorydale Plant of the Procter and Gamble Company has been arranged for women. In the afternoon a sightseeing trip for family groups will visit points of interest in the city and environs, including Cincinnati's famous parks, university, art academy, Rookwood pottery, etc. There also will be a "communications tour" on Friday afternoon for those who wish to visit the studios and transmitter of Station WLW and the Crosley television station, as well as a trip to the Columbia station of the Cincinnati Gas and Electric Company.

Cincinnati has many fine golf clubs where devotees of the game will find opportunities to demonstrate their prowess. No tournament has been scheduled, but the entertainment committee will arrange for play upon request.

The University of Cincinnati will play a night game of football with Centre College on Saturday, October 12. Other major games in nearby cities will be readily accessible.

**Hotel Rates**

| | Room With Bath | |
|---|---|---|
| | Single | Double |
| Netherland Plaza, 5th and Race Sts. | $3.00–10.00 | $5.50–12.00 |
| Gibson, 5th and Walnut Sts. | 2.50– 6.00 | 4.00– 8.00 |
| Sinton, 4th and Vine Sts. | 3.00– 6.00 | 4.50– 9.00 |
| Metropole, Walnut Street | 2.25– 3.00 | 3.50– 6.00 |
| Alms, McMillan and Victory Parkway | 2.50– 4.00 | 4.00– 6.00 |

### STUDENT BRANCH CONVENTION

The sessions, entertainment, and inspection trips of the Student Branch convention are open to all Enrolled Students. They are cordially invited to be present at the smoker and buffet dinner on Wednesday evening. A special price of 75 cents prevails for Students.

Of particular interest is the student-counselor luncheon to be held at noon Thursday, October 10, in the Netherland Plaza Hotel. The price of this luncheon is $1.00 to counselors, 75 cents to students. The inspection trip to the Newport, Ky., plant of the Andrews Steel Company probably will be a feature of the student program. Detailed information for student members is scheduled to reach all Branches in the District about three weeks prior to the convention.

### REGISTRATION AND HOTELS

Members who plan to attend the meeting should register in advance. A minimum registration fee of $2.00 will be charged all nonmembers, except Enrolled Students and the immediate families of members.

Room reservations should be made by writing directly to the hotel preferred. Room rates for the headquarters hotel, Netherland Plaza, as well as several of the other hotels, are given in the accompanying table.

### COMMITTEES

*District meeting:* C. T. Sinclair, vice-president, Middle Eastern District; W. J. Lyman, secretary, Middle Eastern District; A. C. Burroway, L. R. Culver, E. S. Fields, R. W. Prince, V. G. Rettig, M. S. Schneider.

*General:* E. S. Fields, *chairman;* C. F. Lee, chairman, Cincinnati Section; L. L. Bosch, A. C. Burroway, L. R. Culver, C. Fortenbaugh, J. A. Noertker, Mrs. J. A. Noertker, V. G. Rettig, M. S. Schneider.

# Tentative Program—Middle Eastern District Meeting

## Wednesday, October 9

### 9:30 a.m. General Meeting

E. S. Fields, presiding

Welcome. **James Garfield Stewart**, mayor of Cincinnati

Acceptance. **C. T. Sinclair**, vice-president, Middle Eastern District

### 10:00 a.m. General Session

DP.* Sun-Spot Disturbance of Terrestrial Magnetism. **W. F. Davidson**, Consolidated Edison Company of New York, Inc.

DP.* Long-Term Weather Forecasting. **C. G. Rossby**, Weather Bureau

DP.* Fundamental Considerations of the Mill Creek Valley Barrier Dam Flood-Pump Project. **W. A. Farris, H. A. Seaman**, and **R. C. Vogt**, United States Engineers

40-161. A Push-Button Tuned 50 Kw Broadcast Transmitter. **R. J. Rockwell** and **H. Lepple**, WLW, Crosley Radio Corporation

### 2:00 p.m. Power Transmission and Distribution

40-143. Increased Capacity and Interconnections of the Columbia Gas and Electric Corporation. **C. W. DeForest**, Columbia Engineering Corporation

DP.* High-Capacity Air-Blast Circuit Breakers. **H. E. Strang**, General Electric Company

40-137. The Effect of Overexciting Transformers on System-Voltage Wave Shapes and Power Factor. **J. W. Butler** and **E. B. Pope**, General Electric Company

40-144. Some Insulator Designs Require Special Features to Insure Radio Quietness. **C. J. Miller, Jr.**, Ohio Brass Company

40-160-ACO.† Developments in Carbon-Dioxide Fire Extinguishing Systems and Application to Electrical Machinery and Equipment. **Eric Geertz**, Cardox Corporation

### 2:00 p.m. Aviation Instruments and Control

DP.* Automatic Control of Aircraft. **C. D. Barbulesco**, Antioch College

DP.* Application of Electrical Power in Aircraft. **T. B. Holliday**, United States Army Air Corps

DP.* Electrically Operated Remote Indicating Instruments. **G. F. Tate**, United States Army Air Corps

40-157. An Electrical Engine Indicator for Measuring Static and Dynamic Pressures. **E. J. Martin, C. E. Grinstead**, and **R. N. Frawley**, General Motors Corporation

DP.* Aircraft Lighting. **A. D. Dickersen**, United States Army Air Corps

Photo-offset copies of authors' manuscripts, except addresses, may be obtained as soon as available in advance of the meeting by writing to the AIEE order department, 33 West 39th Street, New York, N. Y. Only numbered papers will be available in advance-copy form. If ordered by mail, price 10 cents per copy; if purchased at Institute headquarters or at the convention, 5 cents per copy. Mail orders (particularly from out-of-town members) are advisable, as an adequate supply of each paper at the meeting cannot be assured. Coupon books in $1 and $5 denominations are available for those who wish to avoid remittance by check or otherwise. Most of the papers ultimately will be published in ELECTRICAL ENGINEERING or the TRANSACTIONS.

## Thursday, October 10

### 9:00 a.m. Electrical Machinery

40-138. The "Black-Band" Method of Commutation Observation. **T. W. Schroeder** and **J. C. Aydelott**, General Electric Company

40-159-ACO.† Large 3,600-RPM Induction Motors. **P. C. Smith**, Westinghouse Electric and Manufacturing Company

40-155-ACO.† A New Development in Wound-Core Distribution Transformers. **J. O. Fenwick** and **D. E. Wiegand**, Line Material Company

40-158. A New Current-Limiting Fuse. **H. L. Rawlins, A. P. Strom**, and **H. W. Graybill**, Westinghouse Electric and Manufacturing Company

40-145-ACO†. Load-Regulating Transformer for a High-Voltage Loop. **E. H. Bancker**, General Electric Company, **S. M. Hamill, Jr.**, and **J. W. Hanson**, Cincinnati Gas and Electric Company, and **M. H. Sauter**, General Electric Company.

### 9:00 a.m. Industrial Power Applications

40-146. The Application of Ignitrons to Resistance-Welding Control. **M. E. Bivens**, General Electric Company

40-142. Two New Methods of Accelerating Electric Motors Automatically. **John D. Leitch**, The Electric Controller and Manufacturing Company

40-147. Testing of Elevator Oil Buffers by Electrical Means. **E. E. Kimberly**, Ohio State University

40-148. Fault Voltage Drop and Impedance at Short-Circuit Currents in Low-Voltage Circuits. **O. R. Schurig**, General Electric Company

DP.* Aircraft Vibration Testing Equipment. **R. F. Conner**, United States Army Air Corps

DP.* Airdrome Lighting. **W. T. Harding**, United States Army Air Corps

## Friday, October 11

### 9:00 a.m. Selected Subjects

DP.* Progress in Two-Way Radio for Utilities, Police, and Similar Services. **F. M. Link**, F. M. Link Radio Company

40-149-ACO.† Short-Wave Diathermy Apparatus and Frequency-Control Possibilities. **C. K. Gieringer**, The Liebel-Flarsheim Company

40-156. Radiant Heat—A Full-Fledged Industrial Tool. **P. H. Goodell**, C. M. Hall Lamp Company

40-150. A Comparison of the Relative Efficiency of the Schafer and Pole-Top Methods of Artificial Respiration. **W. B. Kouwenhoven, D. R. Hooker**, and **O. R. Langworthy**, The Johns Hopkins University

DP.* Aircraft Engine Starters. **H. L. Carpenter**, United States Army Air Corps

### 9:00 a.m. Single-Phase Motors

J. L. Hamilton, presiding

40-139. The Use of Auxiliary Impedances in the Single-Phase Operation of Polyphase Induction Motors. **R. W. Ager**, University of California

40-140. The Cross-Field Theory of the Capacitor Motor. **A. F. Puchstein** and **T. C. Lloyd**, Robbins and Myers, Inc.

40-151-ACO.† Single-Phase Motor Theory—A Correlation of the Cross-Field and Revolving-Field Concepts. **C. T. Button**, The Holtzer-Cabot Electric Company

40-152. Performance Calculations on Repulsion Motors. **P. H. Trickey**, Diehl Manufacturing Company

40-153. Performance Calculations on Capacitor Motors. **P. H. Trickey**, Diehl Manufacturing Company

40-141. Single-Phase Induction-Motor Performance Calculation. **F. S. Himebrook**, The Master Electric Company

40-154. Design Factors Involved in the Design of Domestic Motored Appliances. **L. C. Packer**, Westinghouse Electric and Manufacturing Company

### 2:00 p.m. Conference on Motors

This conference will consist of short presentations and extemporaneous discussions on some of the practical problems involved in the design, manufacture, and operation of electric motors. The conference is planned to supplement the formal papers presented in the morning session on single-phase motors, which deal largely with the theoretical aspects of motor design.

*DP: District paper, for which no advance copies are available; not intended for publication in TRANSACTIONS.

†ACO: Advance copies only available; not intended for publication in TRANSACTIONS.

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*Meetings and papers:* L. L. Bosch, *chairman;* C. K. Gieringer, C. M. Mason, W. C. Osterbrock, P. H. Rutherford, P. B. Stewart.

*Hotels and registration:* V. G. Rettig, *chairman;* Wm. Breuning, and C. D. Coy.

*Student sessions:* L. R. Culver, *chairman;* Wynne Gulden, Don Michael.

*Publicity and attendance:* A. C. Burroway, *chairman;* F. J. Breen, Jr., L. J. Fritz, Elmer Nuezel.

*Inspection and transportation:* J. A. Noertker, *chairman;* A. E. Cavagnaro, J. L. Clagett, E. G. Schlup.

*Finance:* M. S. Schneider, *chairman;* H. E. Deardorff, E. J. Jonas, O. C. Schlemmer.

*Entertainment:* Cowden Fortenbaugh, *chairman;* N. J. Bukey, Lincoln Higgins, C. W. Parsons.

*Women's entertainment:* Mrs. J. A. Noertker, *chairman;* Mrs. L. L. Bosch, Mrs. J. T. Bronson, Mrs. A. C. Burroway, Mrs. G. W. Coulehan, Mrs. H. E. Deardorff, Mrs. E. S. Fields, Mrs. C. K. Gieringer, Mrs. C. F. Lee, Mrs. Eric O'Hara, Miss Julia Surnbrock.

# National • • • •

## Changes in Institute Committees

By recent actions of the board of directors, two new technical committees have been created, the names and scope of two other technical committees altered, and one committee changed in status from technical to general.

The new technical committees are the committee on domestic and commercial applications, the scope of which will include applications of electricity to refrigeration, and the committee on air transportation. At the same time that the latter committee was established, the committee on transportation was changed to the committee on land transportation, and the committee on applications to marine work was changed to the committee on marine transportation.

The committee on research, formerly a

technical committee, is now a general committee. This change is expected to eliminate some duplication of the work of other technical committees, which are concerned with research in their various fields; to stimulate research which concerns the Institute; and to give research in electrical engineering a more general and representative status than it has had in the past.

Membership for 1940–41 in these and other Institute committees is listed on pages 377–81.

## Board of Directors Meets

The regular meeting of the AIEE board of directors was held at Institute headquarters, New York, N. Y., August 2, 1940. As a result of a report of the committee on planning and co-ordination concerning a suggestion previously referred to that committee for the establishment by the Institute of a technical committee on the subject of electricity in aviation, the board voted to establish a new technical "committee on air transportation," and to change the name of the committee on transportation to "committee on land transportation," and that of the committee on applications to marine work to "committee on marine transportation."

Upon request of the Engineers' Council for Professional Development, the board approved a change in the charter of ECPD to admit the Engineering Institute of Canada as a participating body of ECPD.

Announcement was made of the appointment by the president of Institute committees for the administrative year beginning August 1, 1940 (see list, pages 377–81).

The following actions also were taken on committee appointments:

*Edison Medal committee*

Appointments confirmed:

**L. W. W. Morrow,** chairman, 1940–41

**Karl T. Compton, W. D. Coolidge, J. M. Thomson,** five-year term beginning August 1, 1940

Elected by board from own membership:

**T. F. Barton, R. E. Hellmund, D. C. Prince,** two-year term beginning August 1, 1940

*Lamme Medal committee*

Appointments confirmed:

**Mark Eldredge, R. E. Hellmund, M. J. Kelly,** three-year term beginning August 1, 1940

*Charles LeGeyt Fortescue Fellowship committee*

Reappointments confirmed:

**C. A. Powel, D. C. Prince,** three-year term beginning August 1, 1940

Institute representatives on various organizations were reappointed as follows:

*Marston Medal board of award*

**Bion J. Arnold,** four-year term beginning August 1, 1940

*ECPD*

**F. Ellis Johnson,** three-year term beginning October 1940

*UET, Inc., board of trustees*

**H. R. Woodrow,** four-year term beginning October 1940 (Mr. Woodrow died August 12, 1940; see page 375 for obituary item.)

*UET, Inc., Library board*

**W. A. Del Mar,** four-year term beginning October 1940

*Engineering Foundation, research procedure committee*

**L. W. Chubb,** one-year term beginning October 1940

The following local honorary secretaries of the Institute were reappointed for the two-year term beginning August 1, 1940:

V. J. F. Brain, Australia
A. S. Garfield, France
V. F. Critchley, Northern India
M. N. Iengar, Southern India
W. Elsdon-Dew, Transvaal

Other actions taken included the following:

Minutes of the meeting of the board of directors held June 27, 1940, were approved.

A report of a meeting of the board of examiners held July 25, 1940, was presented and approved. Upon recommendation of that board, the following actions were taken: 11 applicants transferred to the grade of Fellow; 41 transferred and 21 elected to the grade of Member; 102 elected to the grade of Associate; 18 Students enrolled.

Expenditures in July, amounting to $30,926.13, were reported by the chairman of the finance committee and were approved by the board.

Those present were:

*President*—R. W. Sorensen, Pasadena, Calif.

*Junior past presidents*—F. Malcolm Farmer and John C. Parker, New York, N. Y.

*Vice-presidents*—J. W. Barker, New York, N. Y.; K. L. Hansen, Milwaukee, Wis.; Everett S. Lee, Schenectady, N. Y.; Fred R. Maxwell, Jr., University, Ala.; C. T. Sinclair, Pittsburgh, Pa.; A. LeRoy Taylor, Salt Lake City, Utah; J. M. Thomson, Toronto, Ont.; A. L. Turner, Omaha, Nebr.

*Directors*—T. F. Barton, C. R. Beardsley, and H. S. Osborne, New York, N. Y.; M. S. Coover, Ames, Iowa; Mark Eldredge, Memphis, Tenn.; R. E. Hellmund, East Pittsburgh, Pa.; L. R. Mapes Chicago, Ill.; F. J. Meyer, Oklahoma City, Okla.; D. C. Prince, Schenectady, N. Y.; R. G. Warner, New Haven, Conn.

*National treasurer*—W. I. Slichter, New York, N. Y.

*National secretary*—H. H. Henline, New York, N. Y.

## Lamme Medal Nominations

Attention is called again to the opportunity open to any Institute member to submit nominations for the 1940 AIEE Lamme Medal. All nominations must be received not later than December 1. For further particulars see ELECTRICAL ENGINEERING, June 1940, page 250. The 1939 Medal was awarded to Norman W. Storer, retired consulting railway engineer, Westinghouse Electric and Manufacturing Company.

# District • • • •

## District 4 Executive Committee Meets at Swampscott

Meeting, June 26, 1940, at the New Ocean House, Swampscott, Mass., during the Institute's recent summer convention, the executive committee of the Southern District (4) discussed plans for the District meeting authorized by the board of directors to be held in New Orleans, La., in the fall of 1941. Co-operation of Section chairmen was urged to encourage attendance and technical papers for the meeting from members in the District. The next District conference on student activities will be held at Tuscaloosa, Ala., in the spring of 1941, it was announced. The interest of the Georgia Section in having the 1942 AIEE summer convention held at Atlanta was expressed.

Other matters discussed included state registration laws for engineers and the problems encountered in forming the new South Carolina Section, particularly questions of eligibility and local members.

Those present were:

*Delegates:* F. R. Maxwell, Jr., vice-president; A. S. Hoefflin, secretary; W. J. Miller, student counselor; W. W. Hill, Alabama; K. E. Hapgood, East Tennessee; Joseph Weil, Florida; J. O'D. Shepherd, Georgia; J. M. Houchens, Louisville; E. J. Biegel, Memphis; B. M. Anthony, Muscle Shoals; E. B. Mabson, New Orleans; G. O. Bason, North Carolina; T. F. Ball, South Carolina; F. W. Smith, Virginia.

*Others:* Mark Eldredge, past vice-president, Memphis; C. A. Perkins, B. H. McCoin, J. E. Housley, R. W. McEver, all of East Tennessee.

## *Future AIEE Meetings*

**Middle Eastern District Meeting**
Cincinnati, Ohio, October 9–11, 1940

**Winter Convention**
Philadelphia, Pa., January 27–31, 1941

**Great Lakes District Meeting**
Fort Wayne, Ind., April 1941

**North Eastern District Meeting**
Rochester, N. Y., May 1941

**Summer Convention**
Toronto, Can., June 16–20, 1941

# Abstracts • • •

TECHNICAL PAPERS are previewed in this section as they become available in advance pamphlet form. Copies may be obtained on payment of price indicated to the AIEE order department, 33 West 39th Street, New York, N.Y.

The papers previewed in this issue will be presented at the Middle Eastern District meeting, Cincinnati, Ohio, October 9–11, 1940.

## Electrical Machinery

**40-152—Performance Calculations on Repulsion Motors;** *P. H. Trickey (M'36). 10¢.* A method of calculating the performance of repulsion motors is developed for the purpose of predetermining the torques and currents, especially for repulsion-start induction-run motors during the starting period. The method is based on the cross-field theory presented by H. R. West. It is developed along similar lines to the single-phase calculation method of C. G. Veinott, and is intended for use in connection with it. The paper presents also the results of investigation showing the effects of varying the several motor constants, and a method of determining the effect of brush resistance.

**40-153—Performance Calculations on Capacitor Motors—Part I. The Revolving Field Theory;** *P. H. Trickey (M'36). 10¢.* A method is presented whereby the equations of capacitor motor performance calculation as developed by W. J. Morrill are arranged in a calculation sheet for use in routine design work. W. J. Morrill's classic paper on "The Revolving Field Theory of the Capacitor Motor", presented in 1929,

gave the complete equations for calculating the performance and torque of a capacitor motor at any value of slip. The equations are straightforward, but involve vector operations, and are rather slow for routine design work. Since 1929, many engineers have used the method, and have devised different methods of doing the many numerical operations necessary to obtain a final solution. These have varied from using the equations directly as written, making each vector operation as necessary, to working up a calculation sheet where all operations were numerical. Most engineers involved in motor design work, however, feel that any great number of vector operations in the midst of routine work brings considerable risk of errors, and like to avoid vectors where possible. The writer has developed a calculation sheet for using these formulas, where all the operations except the last in calculating the currents are performed without vectors. This seems to be a fairly satisfactory compromise, and has worked out quite well in practice.

**40-141—Single-Phase Induction-Motor Performance Calculation;** *F. S. Himebrook (M'39).* *10¢.* In the manufacture of electrical machines it is always desirable to calculate the performance of a machine before its construction to determine whether or not it will meet the specifications. This paper describes the development of a method which may be used to plot, as families of curves, the quantities necessary for the performance calculation of single-phase induction motors. The results obtained by the use of the curves indicate that when the original work is carefully carried out considerable time may be saved and results obtained which are as accurate as usually might be obtained by the construction of a special diagram for each motor.

**40-138—The "Black-Band" Method of Commutation Observation;** *T. W. Schroeder (A'37) and John C. Aydelott (M'32).* *10¢.* Good commutation is essential for the reliable performance of d-c machines with low maintenance costs. As an aid to the commutation adjustment of machines in the factory, or in the field, a systematic test procedure has been found useful on large machines to indicate certain features of the machine's adjustment, notably the commutating field strength and brush position. This information is obtained directly from curves known as "black bands" or "buck-and-boost curves" plotted from test observations. The significance and interpretation of these curves in terms of machine adjustments, differential between commutation-reactance voltage and voltage induced by interpole flux are presented and results of observations on machines for special service are given.

**40-140—The Cross-Field Theory of the Capacitor Motor;** *A. F. Puchstein (M'27) and T. C. Lloyd (A'31).* *10¢.* The cross-field theory has been successfully applied to plain single-phase induction-motor analyses, but heretofore no application of this theory has been made to the capacitor motor. This paper is an exposition of such an analysis. A number of examples have been calculated, one of which is shown. The final data are tabulated along with results on the same motor as obtained through other analyses. Considerable experience in handling these equations has led the writers to the belief that for time involved and complexity of calculation there is little to choose between the double-revolving and the cross-field theories.

**40-139—The Use of Auxiliary Impedances in the Single-Phase Operation of Polyphase Induction Motors;** *Raymond W. Ager (A'24).* *10¢.* If a polyphase motor is operated from a single-phase line and auxiliary impedances are used to shift the phase currents and the motor terminal voltages so that the currents and voltages of the motor are properly balanced both as to phase and magnitude, the motor willl operate as though it were supplied from its normal polyphase line. Because the motor current and power factor both change as the speed changes, the impedances required also must change with the motor speed. This study of the impedance variations was made with the idea that general conclusions regarding these impedances might be drawn. The results of this analysis show that no appropriate values of impedance can be found for the full-speed running conditions which will give polyphase performance for more than a single point.

### Electronics and Electric Welding

**40-146—The Application of Ignitrons to Resistance-Welding Control;** *M. E. Bivens* *10¢.* The object of this paper is to review ignitron characteristics and to point out the operating principles which should be considered in order to insure successful applications. In the field of resistance-welding control the ignitron has been proved to possess a combination of characteristics, such as high current-carrying capacity, efficiency, ease of control, reliability, instantaneous operation, no moving parts, quietness, and long life, unequaled by any other device. This brief description of its design and operation may be desired by those who have not followed its development closely or realized its usefulness as exemplified by its expansion of the field of resistance-welding control.

### Industrial Power Applications

**40-142—Two New Methods of Accelerating Electric Motors Automatically;** *J. D. Leitch (A'38).* *10¢.* The first of the two methods discussed in this paper is particularly applicable to a-c slip-ring motors. Series resonance circuits responsive to the variation in rotor frequency with motor speed provide a means of accelerating the motor automatically, while a series-parallel resonance circuit similarly connected to the rotor can be used to protect the motor when "plugged" or suddenly reversed. The sensitive response of the latter circuit within a narrow frequency range makes possible its use as a "zero-speed" switch. The second method can be used with any type of motor. A neon-tube timing-circuit measures the time intervals between the closures of accelerating contactors. One "timer" can be used for all steps of acceleration, with or without separate time adjustment. For a-c motor control, the introduction of a current transformer and a rectifying circuit makes possible the obtaining of time intervals which are increased automatically with increase in motor load. Such a scheme is often referred to as "time-current" acceleration, in order to distinguish it from "constant-time" acceleration, where the time interval is independent of the load.

### Instruments and Measurements

**40-147—Testing of Elevator Buffers by Electrical Means;** *E. E. Kimberly (A'34).* *10¢.* The purpose of an elevator buffer is to stop the elevator in event it reaches the bottom of its hoistway out of control. To prevent injury to its occupants, the rate of stopping must not exceed 2$^1/_2$ times gravity or about 80 feet per second for more than $^1/_{25}$ second. The tests on a buffer should be such that the velocity at which the elevator strikes the buffer and the rate of deceleration at every point in the piston stroke may be determined. If the buffer contains oil, it is important for the designer to know also the oil pressure at every point in the stroke. To determine the striking velocity of the elevator car, a magnetic pick-up coil and grooved iron rod are used. The oil-pressure gauge consists of an oil-pressure cylinder and a carbon pile calibrated in resistance versus pressure.

### Power Transmission and Distribution

**40-137—The Effect of Overexciting Transformers on System Voltage Wave Shapes and Power Factor;** *J. W. Butler (M'38) and E. B. Pope (A'38).* *10¢.* Measurements of harmonics made by the authors on various systems in the United States show in general that the harmonic voltages increase in magnitude as the measurements are made farther and farther from the generating stations. This indicates that transformer exciting currents probably have more effect on system wave shapes than is usually believed. Some of the conclusions are that the over-all system power factor can be materially reduced by exciting currents resulting from *excessive* overexcitation of the majority of the transformers, and that the use of capacitors and reactors in series for the dual purpose of power-factor and wave-form improvement provides a simple, effective, and economically sound method of coping with the problems presented by the overexcitation of transformers.

## Standards • • •

### Standards Manual

In seeking ways and means by which it could be of greatest service in furthering the development of electrical standardization, the AIEE standards committee during the past year decided to develop a "standards manual". This manual, when completed, will serve as a guide for AIEE standardization work. Two sections are of particular general interest, as they outline two of the most promising lines of activity; these are the sections dealing with "Basic Guiding

Standards" and "Test Codes", which are given here in full.

BASIC GUIDING STANDARDS

Since specific apparatus standards of the more commercial type are prepared by other agencies, such as American Standards Association, National Electrical Manufacturers Association, Edison Electric Institute, etc., the Institute, aside from co-operating with these agencies, can best serve the industry by devoting its attention to certain scientific standards and to basic standards serving as guides for other standardizing bodies. The 1940 revision of AIEE Standards No. 1, "General Principles Upon Which Temperature Limits Are Based in the Rating of Electrical Machinery and Apparatus," has been modified to serve as a basic guiding standard. In this case, the standard proper outlines a method for deriving standards based on temperature rises. It also gives specific values for temperature rises which may be properly applied to a large percentage of apparatus and it suggests various methods of determining temperature rises and their preferred fields of application. At the same time it freely recognizes that technical or economic considerations may make departures from the values or methods given not only permissible but desirable for many specific types of apparatus or applications. However, in order to avoid the use of too many different values, it gives a table of preferred values, to be used in temperature-rise standards whenever possible. Other important parts of the standard contain definitions for such items as the various classes of insulation, ambient temperature, etc., which preferably should be used uniformly in all other standards for apparatus. In other words, an attempt has been made, without assuming any mandatory attitude, to guide other standardizing agencies with the intent of furthering the development of a free but co-ordinated system of electrical standards.

Inasmuch as this standard is to serve as a guide, it has been considered advisable to give in a preface basic considerations, such as general concepts, economic considerations, etc., which should assist in the interpretation of the standard proper. For similar reasons, an appendix was added, giving data that should be helpful in the preparation of standards and their application. In this particular standard, statistical temperature data for the United States and Canada are given and also a bibliography of publications dealing with temperature-rise problems in electrical machines and apparatus.

It is hoped that this brief outline will assist in the preparation of similar basic and guiding standards by the Institute.

TEST CODES

One of the most useful standards activities of the Institute during recent years has been the preparation of test codes and increased activity of this nature seems desirable.

Test codes can be of two classes, namely:

1. Codes applying to specific types of apparatus, conductors, etc., such as induction motors, synchronous motors, d-c machines, cables, etc.

2. Master codes relating to test methods for certain quantities common to many types of apparatus, etc. A test code for apparatus noise measurement is now available. Other master codes might be worked out for

(*a*) Method for resistance measurements

(*b*) Method for insulation testing

(*c*) Test methods for telephone interference

(*d*) Test methods for radio interference

(*e*) Test methods for determining temperature rises of machines and apparatus

These master test codes should be prepared in such a way that they can be referred to in whole or in part in any of the apparatus test codes, and also so that any master code or parts of a code can be used as an integral part of apparatus test codes. Considerable flexibility in this respect is desirable, because it is difficult to include everything relating to one line of apparatus in the test code for that apparatus without making it unduly bulky. On the other hand, it is inconvenient if an apparatus test code makes reference to a great many master codes. Those preparing apparatus test codes should therefore be able to choose the most advantageous compromise for each particular case.

Test codes in general should be confined to the description of test methods, although in some cases guidance for the interpretation of test results may be helpful. The codes should avoid the inclusion of standards provisions such as limiting values, ratings, etc. If in exceptional cases the inclusion of such data seems necessary either for convenience or clarification, it should be given in the form of footnotes and with definite identification of the standard quoted. Reference to specific standards in footnotes may also be justified at times.

In general, test codes should be issued as AIEE standards, although their adoption by the American Standards Association may be approved whenever desirable.

**Protector Tubes.** Report No. 24 on "Proposed Standards for Protector Tubes" is now available for purposes of criticism and the general information of the industry. This has been prepared by a subcommittee of the AIEE committee on protective devices, working under the chairmanship of I. W. Gross, American Gas and Electric Company. The standards apply to all types of protector tubes designed to limit voltage surges on 60-cycle a-c power circuits. They do not apply to special types of protector tubes used to protect transformers. As this proposed standard is in report form copies may be obtained without charge by writing AIEE headquarters, 33 West 39th Street, New York, N. Y.

# Personal . . .

**G. W. Faller** (M'36) has been elected president of the Public Service Company of Colorado, Denver. He was born at North Freedom, Wis., April 16, 1878, and in 1898 was graduated from the United States Naval Academy where he had taken the engineers' course. Following five years' service as a commissioned officer in the Navy, he resigned to enter the employ of the Madison (Wis.) Gas and Electric Company. In 1905 he became engineer of gas distribution for the Denver Gas and Electric Company (later Denver Gas and Electric Light Company), advancing to the position of assistant superintendent in charge of gas and steam heat operations. He went with the City Light and Water Company, Amarillo, Tex., in 1913, as general superintendent, later becoming vice-president and general manager, and serving during the same period (1913–23) as treasurer and vice-president of the Amarillo Street Railway Company. From 1923 to 1930 he was associated with Denver Gas and Electric Light Company and Public Service Company of Colorado as assistant manager, director of the Doherty Training School, and vice-president. He was district manager of Henry L. Doherty and Company and of Alpha Distributors, Inc., 1930–34. Since 1934 he had been vice-president and general manager of Public Service Company of Colorado.

**J. H. Gardner, Jr.** (A'25, M'34) major, Signal Corps, United States Army, has been appointed director of the Aircraft Radio Laboratory, Wright Field, Dayton, Ohio. He was born at Altamont, N. Y., October 10, 1893, and received the degrees of bachelor of science in electrical engineering, 1913, and master of science, 1915, from Union College, and that of master of science in electrical engineering from Yale University in 1924. From 1913 to 1917 he was employed by the General Electric Company, first in the test course and later in the light engineering department, at Schenectady, N. Y., and Chicago, Ill. He entered the United States Army in 1917, becoming a radio and telephone officer in the Field Artillery, and from 1919 to 1921 was with the Intelligence Section of the American forces in Germany. He was transferred to the Signal Corps in 1921, in 1925 became assistant to signal officer, Fifth Corps Area, Columbus, Ohio, and in 1926 executive officer in charge of research and engineering in the office of the chief signal officer, Washington, D. C. In 1931 he became executive officer of the Signal Corps Laboratories, Fort Monmouth, N. J., later returning to the office of the chief signal officer in Washington. He had been executive officer of the Aircraft Radio Laboratory before being appointed director.

**C. E. Stryker** (A'21, F'35) formerly partner in the management engineering firm of McKinsey, Keraney, and Company, Chicago, has been appointed vice-president and assistant to the president of the Nordberg Manufacturing Company, Milwaukee, Wis. Born at Chicago, Ill., February 27, 1897, he received the degree of bachelor of science in electrical engineering from Armour Institute of Technology in 1917 and that of electrical engineer in 1924. He was a testing engineer for Commonwealth Edison Company, 1917–19; engineer and purchasing agent for the Ozone Pure Airifier Company, 1919–21; assistant electrical engineer, Underwriters Laboratories, 1922–23; and in 1923 became electrical engineer for Fansteel Products Company, Inc., all of Chicago. From 1920 to 1924 he was concurrently assistant professor of electrical engineering at Armour Institute of Technology. He continued with the Fansteel company until 1935, becoming manager of the industrial division and later chief engineer. He had been with McKin-

sey, Kearney, and Company for five years, becoming a partner in 1938. He is also a member of the Society of Automotive Engineers.

**E. F. Scattergood** (A'08, F'13) has retired as general manager and chief electrical engineer of the Bureau of Power and Light, City of Los Angeles, Calif. He will be retained for five years in an advisory capacity. Born April 9, 1871, near Burlington, N. J., he received the degrees of bachelor of science, 1893, and master of science, 1896, from Rutgers University, and that of master of mechanical engineering from Cornell University in 1899. From 1899 to 1901 he was professor of physics and electrical engineering at Georgia School of Technology, Atlanta. He was a special engineer in the joint electrical engineering office of the Pacific Light and Power, Pacific Electric Railway, and Los Angeles Railway companies at Los Angeles, 1902–06, and for the next three years had a consulting office in that city. In 1909 he became chief electrical engineer for the City's Bureau of Aqueduct Power, and in 1911 electrical engineer for the Department of Public Service. When the Bureau of Power and Light was created he became its chief electrical engineer and general manager, and has held those positions ever since.

**H. C. Gardett** (A'07, M'19) has been appointed chief electrical engineer and general manager of the Bureau of Power and Light of the City of Los Angeles, Calif. Born March 2, 1878, at Poso Flat, Calif., he received the degree of bachelor of science from the University of California in 1904. During 1904 he was employed on electrical jobs by R. S. Mason, consulting engineer, and in 1905 went to work for the Pacific Electric Railway Company, Los Angeles, as meter inspector, later becoming foreman. In 1907 he entered consulting practice in Los Angeles under E. F. Scattergood (A'08, F'13), and in 1909 became assistant to Mr. Scattergood for the Los Angeles Bureau of Aqueduct Power. He became assistant electrical engineer in 1912 for the city's Department of Public Service, and design and construction engineer of the Bureau of Power and Light in 1917. For several years he had been assistant chief electrical engineer and assistant general manager. **Roy Martindale** (M'21) formerly electrical engineer in charge of operations, Bureau of Power and Light, has been appointed assistant chief electrical engineer. A graduate (1906) of Purdue University, he was employed by General Electric Company, Schenectady, N. Y., and the Washington Water Power Company, Spokane, before being employed by the City of Los Angeles in 1911. He became assistant operating engineer of the Bureau of Power and Light in 1920 and electrical engineer in charge of operations in 1939.

**Gano Dunn** (A'91, F'12) president, J. G. White Engineering Corporation, New York, N. Y., has been appointed chairman of the advisory power committee organized by the National Defense Advisory Commission to co-ordinate electric-power supplies for industries engaged in national defense production. Doctor Dunn was a member of the engineering committee of the Council of National Defense during the World War. A biographical sketch of him appeared in the November 1939 issue, page 489. **C. W. Kellogg** (A'19, M'23) president, Edison Electric Institute, New York, N. Y., has been appointed a member of the power committee and has been granted a leave of absence from his present duties to serve in that capacity.

**D. C. Jackson** (A'87, F'12) professor emeritus of electrical engineering, Massachusetts Institute of Technology, Cambridge, has been appointed chairman of a new committee of American Engineering Council, designated to prepare a code of ethics for the engineering profession (*EE, Aug. '40, p. 328*). Doctor Jackson, who was president of the Institute 1910–11, is chairman of its committee on code of principles of professional conduct.

**F. B. Jewett** (A'03, F'12) vice-president, American Telephone and Telegraph Company, and president, Bell Telephone Laboratories, New York, N. Y., has been appointed a member of the National Defense Research Committee, and is serving as chairman of the subcommittee on communication and transportation.

**W. H. Harrison** (A'20, F'31) vice-president and chief engineer of the American Telephone and Telegraph Company, New York, N. Y., has been appointed director of the construction division of the production division of the National Defense Advisory Commission.

**P. J. Kiel** (A'37) has been transferred from Chase Brass and Copper Company, Cleveland, Ohio, to Kennecott Wire and Cable Company, as cable sales engineer with headquarters at Phillipsdale, R. I. Both companies are subsidiaries of Kennecott Copper Corporation.

**J. W. Morrison** (A'09, M'32) vice-president and chief engineer, Rochester Telephone Corporation, Rochester, N. Y., has been nominated as a director of the Rochester Engineering Society for 1940–43. He is a past chairman of the AIEE Rochester Section.

**Joseph Gladis** (A'27) former electrical designer, New England Power Service Company, Boston, Mass., is now employed in the switchboard division of the engineering department of the Roller-Smith Company, Bethlehem, Pa.

**L. D. Smullin** (A'37) formerly an engineer for the Farnsworth Television and Radio Corporation, Fort Wayne, Ind., is now employed in the research department of the Scintilla Magneto division, Bendix Aviation Corporation, Sidney, N. Y.

**Ward Harrison** (F'36) director of engineering, lamp department, General Electric Company, Cleveland, Ohio, recently was awarded the honorary degree of doctor of illuminating engineering by the Case School of Applied Science.

**Douglas Montgomery** (A'26) formerly assistant electrical engineer, Illinois Iowa Power Company, Champaign, Ill., is now employed as senior layout draftsman, electrical and radio group, Vega Airplane Company, Burbank, Calif.

**E. A. Armstrong** (A'13, M'32) manager of power sales, Public Service Company of Northern Illinois, Chicago, Ill., has been elected chairman of the board of directors of the Great Lakes Power Club for 1940–41.

**E. O. Shreve** (A'06) vice-president, General Electric Company, Schenectady, N. Y., has been elected a vice-president of the American Management Association for a second term.

**H. P. Liversidge** (A'12, M'17) president, Philadelphia Electric Company, Philadelphia, Pa., recently was awarded the honorary degree of doctor of engineering by Stevens Institute of Technology.

**H. C. Blackwell** (A'09) president, Cincinnati Gas and Electric Company, Cincinnati, Ohio, recently was awarded the honorary degree of doctor of engineering from Purdue University.

**E. B. Currie** (A'36) has been made manager of the Binghamton office of the General Electric Company. He has been with the company since 1925 and before the present appointment was in the Rochester office.

**O. J. Moses** (A'35) formerly engineer, Lynn (Mass.) Gas and Electric Company, is now employed in a similar capacity by the Hartford (Conn.) Electric Light Company.

**Saul Dushman** (A'13) assistant director of the research laboratory, General Electric Company, Schenectady, N. Y., recently was awarded the honorary degree of doctor of science by Union College.

**M. H. Pollyea** (A'37) formerly junior engineer, C. J. Tagliabue Manufacturing Company, Brooklyn, N. Y., is now employed as an instrument engineer by the Sun Oil Company, Toledo, Ohio.

**B. C. J. Wheatlake** (A'16), district manager, General Electric Company, Salt Lake City, Utah, has been elected president of the Salt Lake City Optimist Club.

**L. G. Henry** (A'40) has been employed as assistant to the chief engineer, alkali division, Canadian Industries, Ltd., Shawinigan Falls, Ont., Can.

**J. W. Carpenter** (M'35) president, Texas Power and Light Company, Dallas, was awarded the honorary degree of doctor of laws by Texas Technological College.

**C. A. Pfleiderer** (M'39) equipment engineer, Indiana Bell Telephone Company, Indianapolis, has been appointed building and equipment engineer of that company.

# Obituary • • •

**Harry Ray Woodrow** (A'12, F'23) vice-president in charge of design, planning, and inventory, Consolidated Edison Company of New York, Inc., New York, N. Y., died August 12, 1940. He was born in Minnesota, April 15, 1887, and received the de-

grees of bachelor of science, Drake University, 1909 and master of science, University of Illinois, 1911. He later received the degree of doctor of laws from Drake. In 1911 he joined the staff of the New York (N. Y.) Edison Company as assistant to the chief electrical engineer, and in 1917 was given the title of assistant chief electrical engineer. He went with Stone and Webster, Inc., Boston, Mass., in 1920 as electrical engineer, remaining with that company about two years and with the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., as general engineer for part of a year, before becoming assistant electrical engineer for the Brooklyn (N. Y.) Edison Company late in 1922. He was made electrical engineer in 1926 and vice-president in 1932, and became a director of the company in 1935. He was elected a vice-president of Consolidated Edison in 1937. He served the Institute as a director 1931–35 and had represented the Institute on United Engineering Trustees, Inc., since 1934. He was a member of the committee on Institute policy and formerly had been a member of the committees on membership, protective devices (chairman 1921–25), standards, power transmission and distribution (chairman 1928–30), economic status of the engineer, and of the publication and Edison Medal committees. He was also active in the former National Electric Light Association and in the Association of Edison Illuminating Companies and the American Standards Association, and was also a member of Sigma Xi and Phi Beta Kappa.

**Walter Everette Brown** (A'02) electrical engineer, National Bureau of Standards, Washington, D. C., died May 13, 1940. He was born at Stamford, Conn., May 20, 1874, and received the degree of electrical engineer from Lehigh University in 1897. Following graduation he was employed by the New York and New Jersey Telephone Company and continued with the company until 1910, advancing to the position of equipment engineer. He then became chief inspector for the division of telephony and telegraphy of the New York State Public Service Commission. From 1912 to 1914 he was general superintendent and engineer of the Buelle Company, manufacturer of fire doors, and in 1914–15 held the same position with the Rexolite Company. He was district manager of the St. Louis Fire Door Company 1915–16, vice-president and engineer of the Fowler Bottling Machine Company 1916–18, and became associate electrical engineer for the Bureau of Standards in 1918, later becoming electrical engineer. His service to the Bureau included extensive work in cooperation with the Bureau of Prisons on special telephone equipment for Federal penitentiaries.

**Frank Prague Colville** (M'30) Cincinnati manager, Westinghouse Electric and Manufacturing Company, Cincinnati, Ohio, died July 20, 1940. He was born at Covington, Ky., April 20, 1883, and received the degree of bachelor of science from the University of Cincinnati in 1904. From 1904 to 1906 he was employed in the drafting room of the Bullock Electric Company, Norwood, Ohio, and during the following year was assistant to W. G. Franz, Cincinnati consulting engineer. From 1907 to 1910 he was with the Western Electric Company, spending a year in the shop course in Chicago, Ill., and two years on the sales force in Cincinnati. He was vice-president of the Reno Kaetker Electric Company, Cincinnati, from 1910 to 1918, and after a year as lieutenant in the Engineers Corps of the United States Army, was employed by Eaton Rhodes and Company in charge of the firm's Ashland, Ky., office. He joined the Westinghouse company in 1922 as a salesman in the Louisville, Ky., office. He was made manager of the Dayton, Ohio, office in 1925, manager of the Dayton and Columbus, Ohio, offices in 1928, and manager of the Cincinnati office in 1930.

**William Louis Garrels** (A'95) consulting engineer, Kirkwood, Mo., died recently, according to information just received at Institute headquarters. He was born at St. Louis, Mo., February 12, 1872, and attended Washington University and Cornell University. He received from the latter institution the degrees of mechanical engineer, in 1893, and master of mechanical engineering, in 1894, having specialized in electrical engineering. Following graduation he entered the student course of Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa. During 1895–96 he was representative of the Fruin-Bambrick Construction Company, St. Louis, on the construction of the Holyoke, Mass., stone dam. He had been engaged in private consulting practice since 1897. He held several United States patents, and was also a member of the Franklin Institute.

**Robert John Parmenter** (A'17, M'32) designing engineer, Public Service Company of Northern Illinois, Chicago, Ill., died July 26, 1940. He was born at Elmira, N. Y., September 10, 1890, and received the degree of bachelor of science in electrical engineering from Bucknell University in 1914. During the next two years he was employed by the Elmira Water Light and Railroad Company, first on appraisal work, later on construction and operation. He was an electrical draftsman for Sargent and Lundy, Chicago, Ill., 1916–17, and during 1917–19 served with the United States Army in France as a lieutenant in the Engineers Corps. He entered the employ of Public Service Company of Northern Illinois in 1919, as a draftsman, becoming purchasing engineer in 1924 and designing engineer in 1926.

**Charles Jules Cosandey** (A'27) instructor in physics, mathematics, and electrical engineering at Duluth Junior College, Duluth, Minn., died recently, according to information just received at Institute headquarters. He was born at Lucens, Vaud, Switzerland, October 31, 1894. He received the degree of bachelor of science in electrical engineering from the University of Minnesota in 1925, and that of master of science from Iowa State College in 1926. In 1925–26 he was an assistant and later instructor in electrical engineering at Iowa State College, Ames, and in 1926 he became instructor in radio engineering at the University of South Dakota, Vermillion. He had been an instructor at Duluth Junior College for more than ten years.

**William Sherwood White** (A'39) staff engineer, Bell Telephone Company of Pennsylvania, Philadelphia, died May 7, 1940. He was born May 28, 1905, at Philadelphia, and was graduated in 1928 from the Moore School of Electrical Engineering, University of Pennsylvania. He was employed by the Bell Telephone Company of Pennsylvania in 1929 as an engineering assistant on telephone transmission, and had been with the company continuously except for two years (1935–37) with the Diamond State Telephone Company as repairman on equipment maintenance. Since 1937 he had been a staff engineer assigned to cable and cable equipment studies.

# Membership

## Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Names of applicants in the United States and Canada are arranged by geographical Districts. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the national secretary before September 30, 1940, or November 30, 1940, if the applicant resides outside of the United States or Canada.

**United States and Canada**

1. North Eastern

Drake, F. E., Jr., Rochester Gas and Electric Corporation, Rochester, N. Y.
Lytle, J. A., New England Power Service Company, Providence, R. I.
Peterson, C. H. (Member), Jackson and Moreland, Boston, Mass.

2. Middle Eastern

Finzi, L. A., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Harness, S. A., RFD 3, Federalsburg, Md.
Johnson, C. L. (Member), Rural Electrification Administration, Washington, D. C.
Kesecker, K. S., Navy Department, Washington, D. C.

3. New York City

Aberg, S. T., 101 Park Avenue, New York, N. Y.
Haines, A. B., Bell Telephone Laboratories, New York, N. Y.

4. Southern

Davis, D. H., South Carolina Power Company, Charleston.
Trotta, J. P. (Member), 3012 Morgan Street, Tampa, Fla.

5. Great Lakes

Cleghorn, R. R., Bull Dog Electric Products Company, Detroit, Mich.
Ellithorn, H. E., University of Notre Dame, Notre Dame, Ind.
Heisey, R. E., Bull Dog Electric Products Company, Detroit, Mich.
Johnson, J. A., Chicago Bridge and Iron Company, Chicago, Ill.
Platz, E. T., Bull Dog Electric Products Company, Detroit, Mich.
Togesen, A. A., Bull Dog Electric Products Company, Detroit, Mich.

6. North Central

Goalby, L. A., Westinghouse Electric and Manufacturing Company, Denver, Colo.

7. South West

Kilcrease, J. W., Southwestern Public Service Company, Amarillo, Tex.
Tolk, R., Southwestern Public Service Company, Amarillo, Tex.

9. North West

Lee, C. B., 3201 46th Avenue, S.W., Seattle, Wash.

Total, United States, 21

**Elsewhere**

Fletcher, D., Admiralty, Bath, England.
Serwarey, J. S., V. and P. O., Sialba Majri, District of Ambala, India.

Total, elsewhere, 2

# Officers and Committees for 1940-41

## Officers

### President

R. W. SORENSEN — Pasadena, Calif.
(*Term expires July 31, 1941*)

### Junior Past Presidents

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(*Term expires July 31, 1941*)

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(*Term expires July 31, 1942*)

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10 J. M. THOMSON — Toronto, Ont.
(*Terms expire July 31, 1941*)

EVERETT S. LEE — Schenectady, N. Y.
3 J. W. BARKER — New York, N. Y.
5 K. L. HANSEN — Milwaukee, Wis.
7 J. L. HAMILTON — St. Louis, Mo.
9 A. LEROY TAYLOR — Salt Lake City, Utah
(*Terms expire July 31, 1942*)

### Directors

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VANNEVAR BUSH — Washington, D. C.
F. H. LANE — Chicago, Ill.
(*Terms expire July 31, 1941*)

L. R. MAPES — Chicago, Ill.
H. S. OSBORNE — New York, N. Y.
D. C. PRINCE — Schenectady, N. Y.
(*Terms expire July 31, 1942*)

MARK ELDREDGE — Worcester, Mass.
R. E. HELLMUND — East Pittsburgh, Pa.
F. J. MEYER — Oklahoma City, Okla.
(*Terms expire July 31, 1943*)

T. F. BARTON — New York, N. Y.
M. S. COOVER — Ames, Iowa
R. G. WARNER — New Haven, Conn.
(*Terms expire July 31, 1944*)

### National Treasurer

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(*Term expires July 31, 1941*)

### National Secretary

H. H. HENLINE — New York, N. Y.
(*Term expires July 31, 1941*)

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Parker & Aaron
20 Exchange Place, New York, N. Y.

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ENGLAND—A. P. M. Fleming, Metropolitan Vickers Electric Co., Trafford Park, Manchester.

FRANCE—A. S. GARFIELD, 173 Boulevard Haussmann, Paris, 8E.

INDIA, NORTHERN—V. F. Critchley, 3 Abbot Road, Lahore, Punjab.

INDIA, SOUTHERN—N. N. Iengar, Tata Power Co. Ltd., Bombay House, Bruce St., Fort Bombay.

NEW ZEALAND—P. H. Powell, Canterbury College, Christchurch.

SWEDEN—A. F. Enstrom, Ingeniorsvetenskrapsakademien, Stockholm, 5.

TRANSVAAL, AFRICA—W. Elsdon-Dew, P. O. Box 4563, Johannesburg.

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(*Terms expire July 31, 1941*)

C. R. Jones — Everett S. Lee — H. S. Osborne
(*Terms expire July 31, 1942*)

J. W. Barker — N. E. Funk — W. H. Harrison
(*Terms expire July 31, 1943*)

W. B. Kouwenhoven — F. V. Magalhaes
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(*Terms expire July 31, 1944*)

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(*Terms expire July 31, 1945*)

*Appointed by the board of directors from its own membership for term of two years*

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(*Terms expire July 31, 1941*)

T. F. Barton — R. E. Hellmund — D. C. Prince
(*Terms expire July 31, 1942*)

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W. I. Slichter, national treasurer
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(*Terms expire July 31, 1941*)

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(*Terms expire July 31, 1941*)
O. E. Buckley — Everett S. Lee
(*Terms expire July 31, 1942*)
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(*Terms expire July 31, 1943*)

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F. F. Brand — Howard Maxwell — C. A. Powel
(*Terms expire July 31, 1942*)
Mark Eldredge — R. E. Hellmund — M. J. Kelly
(*Terms expire July 31, 1943*)

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(Personnel not completed at time of publication)

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H. E. Kent — W. C. White
F. R. Lack — F. A. Wolff
J. R. MacGregor — F. C. Young
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### Domestic and Commercial Applications

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P. S. Biegler — W. A. Murray
F. C. Bolton — H. S. Rush
M. S. Coover — A. R. Stevenson, Jr.
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L. F. Fuller — H. N. Walker
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### Electric Welding

(Personnel not appointed at time of publication)

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A. L. Brownlee — L. J. Lunas
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C. T. Burke — C. V. Morey
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C. L. Dawes — E. J. Rutan
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S. S. Green — H. L. Thomson
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F. C. Holtz — H. N. Walker
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Robin Beach
W. T. Blackwell
O. P. Cleaver
H. B. Dates
E. E. Dorting
C. L. Dows
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W. H. Reed
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A. E. Waller
F. A. Wickel
O. A. Wilde
R. J. Wiseman
R. L. Witham
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T. G. LeClair, *vice-chairman*
A. C. Montieth, *secretary*

H. D. Braley
W. R. Brownlee
O. E. Charlton
J. E. Clem
J. O'R. Coleman
H. W. Collins
L. L. Draper
F. R. Ford
I. W. Gross
Herman Halperin
F. C. Hanker
R. T. Henry
P. A. Jeanne
B. M. Jones
L. F. Kennedy
W. A. Lewis, Jr.
H. J. Lingal
F. R. Longley
L. R. Ludwig
J. B. MacNeill
K. B. McEachron
J. W. McFarlin
C. W. McGill
J. W. Milnor
J. H. Neher
H. V. Nye
J. H. Oliver
D. C. Prince
H. P. St. Clair
E. C. Sawyer
A. H. Schirmer
H. K. Sels
H. P. Sleeper
C. L. Smith
L. G. Smith
R. M. Smith
H. R. Stewart
H. R. Summerhayes
J. H. Vivian
H. L. Wallau
A. W. Walton
J. D. Wood

### Power Generation

W. L. Cisler, *chairman*, 80 Park Place, Newark, N. J.

F. A. Annett
C. A. Corney
F. H. Davies
J. J. Dougherty
H. A. Dryar
J. H. Foote
R. L. Frisby
W. D. Hardaway
N. B. Hinson
J. A. Koontz
A. J. Krupy
O. L. LeFever
V. M. Marquis
C. W. Mayott
C. H. McKnight
F. J. Meyer
A. C. Monteith
G. M. Pollard
G. E. Quinan
C. R. Reid
J. R. Smith
E. C. M. Stahl
M. J. Steinberg
Robert Treat
E. C. Williams

### Power Transmission and Distribution

Raymond Bailey, *chairman*, Philadelphia Electric Co., 900 Sansom St., Philadelphia, Pa.
Philip Sporn, *vice-chairman*, American Gas and Electric Service Co., 30 Church St. New York, N.Y.
J. W. Anderson, 3rd, *secretary*, Philadelphia Electric Co., 2301 Market St., Philadelphia, Pa.

D. K. Blake
W. L. Bryant, Jr.
A. B. Campbell
C. V. Christie
H. W. Clark
Harold Cole
E. S. Cornell
C. A. Corney
M. T. Crawford
R. F. Danner
A. F. Darland
E. W. Davis
A. E. Davison
G. E. Dean
Llewellyn Evans
R. D. Evans
D. D. Ewing
Herman Halperin
Edwin Hansson
C. A. Harrington
E. W. Hatz
L. F. Hickernell
E. K. Huntington
J. P. Jollyman
A. A. Kroneberg
W. A. Lewis, Jr.
W. W. Lewis
J. T. Lusignan, Jr.
G. R. Milne
E. W. Oesterreich
J. S. Parsons
W. S. Peterson
S. J. Rosch
E. V. Sayles
H. J. Scholz
A. E. Silver
D. M. Simmons
C. T. Sinclair
F. V. Smith
L. G. Smith
Stanley Stokes
J. J. Torok
H. M. Trueblood
C. F. Wagner
H. S. Warren
R. J. Wiseman
L. F. Woodruff
T. A. Worcester
H. E. Wulfing

## Institute Representatives

**Alfred Noble Prize Committee, ASCE**
H. S. Osborne

**American Association for the Advancement of Science, Council**
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V. Bush

**American Committee on Marking of Obstructions to Air Navigation**
G. E. Dean
H. L. Huber

**American Co-ordinating Committee on Corrosion**
H. S. Phelps

**American Engineering Council, Assembly**
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W. H. Harrison
C. R. Jones
John C. Parker
R. W. Sorensen
H. H. Henline, *Alternate*

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C. T. Sinclair

**American Standards Association, Standards Council**
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**Committee on Heat Transmission, National Research Council**
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**Committee on Low Voltage Hazards, American Society of Safety Engineers—Engineering Section, National Safety Council**
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**Electrical Standards Committee, ASA**
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**Engineering Foundation Board**
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**Engineers' Council for Professional Development**
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**Hoover Medal Board of Award**
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A. W. Berresford
W. McClellan

# Geographical District Executive Committees

| | District | Chairman (Vice-President, AIEE) | Secretary (District Secretary) | Chairman, District Committee on Student Activities |
|---|---|---|---|---|
| 1 | North Eastern | Everett S. Lee, General Electric Co., Schenectady, N. Y. | R. G. Lorraine, General Electric Co., Schenectady, N. Y. | E. A. Walker, Tufts College, Medford, Mass. |
| 2 | Middle Eastern | C. T. Sinclair, Duquesne Light Co., 435 Sixth Ave., Pittsburgh, Pa. | W. J. Lyman, Duquesne Light Co., 435 Sixth Ave., Pittsburgh, Pa. | L. R. Culver, University of Cincinnati, Cincinnati, Ohio |
| 3 | New York City | J. W. Barker, Columbia University, New York, N. Y. | | |
| 4 | Southern | Fred R. Maxwell, Jr., University of Alabama, University, Ala. | A. S. Hoefflin, Louisville Gas and Electric Co., 311 W. Chestnut St., Louisville, Ky. | W. J. Miller, University of Alabama, University, Ala. |
| 5 | Great Lakes | K. L. Hansen, 2916 N. Prospect Ave., Milwaukee, Wis. | A. G. Dewars, Northern States Power Co., 15 S. 5th St., Minneapolis, Minn. | B. S. Willis, Iowa State College, Ames, Iowa |
| 6 | North Central | A. L. Turner, 1112 Telephone Bldg., Omaha, Nebr. | I. M. Ellestad, Telephone Bldg., Room 823, Omaha, Nebr. | H. F. Rice, University of North Dakota, Grand Forks, N. Dak. |
| 7 | South West | J. L. Hamilton, 1806 Pine St., St. Louis, Mo. | L. L. Crump, J. R. Kearney Corp., 4224 Clayton Ave., St. Louis, Mo. | J. S. Johnson, Missouri School of Mines and Metallurgy, Rolla, Mo. |
| 8 | Pacific | H. W. Hitchcock, Southern California Tel. Co., Los Angeles, Calif. | W. F. Grimes, 1324 Wall St., Los Angeles, Calif. | S. G. Palmer, University of Nevada, Reno, Nev. |
| 9 | North West | A. LeRoy Taylor, University of Utah, Salt Lake City, Utah | A. C. Kelm, Utah Power and Light Co., Salt Lake City, Utah | A. L. Albert, Oregon State College, Corvallis, Ore. |
| 10 | Canada | J. M. Thomson, Ferranti Electric Ltd., Mount Dennis, Toronto, Ont. | O. W. Titus, Canada Wire and Cable Co., Ltd., Box 340, Toronto 2, Ont. | |

NOTE: Each District executive committee includes also the chairmen and secretaries of all Sections within the District, and the District vice-chairman of the national membership committee.

### Institute Representatives (continued)

**John Fritz Medal Board of Award**

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**Marston Medal Board of Award**

Bion J. Arnold

**National Bureau of Engineering Registration, Advisory Board**

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**National Fire Protection Association, Electrical Committee**

F. V. Magalhaes, H. S. Warren, *Alternate*

**National Fire Waste Council**

Wills Maclachlan, Frank Thornton, Jr.

**National Research Council, Division of Engineering and Industrial Research**

John C. Parker

**Research Procedure Committee, Engineering Foundation**

L. W. Chubb

**Thomas Alva Edison Foundation**

H. H. Barnes, Jr., Charles F. Scott, L. W. W. Morrow, Clayton H. Sharp

**United Engineering Trustees, Inc.**

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**United States National Committee of the International Electrotechnical Commission**

R. E. Hellmund, V. M. Montsinger, H. S. Osborne

*Alternates:*

H. E. Farrar, E. L. Moreland, E. B. Paxton

**Washington Award Commission**

H. B. Gear, L. W. W. Morrow

## Student Branches of the Institute

| Name and Location | District | Counselor (Member of Faculty) |
|---|---|---|
| Akron, Univ. of, Akron, Ohio | 2 | J. T. Walther |
| Alabama Polytechnic Inst., Auburn | 4 | W. W. Hill |
| Alabama, Univ. of, University | 4 | W. J. Miller |
| Alberta, Univ. of, Edmonton, Alberta, Can | 10 | E. G. Cullwick |
| Arizona, Univ. of, Tucson | 8 | J. C. Clark |
| Arkansas, Univ. of, Fayetteville | 7 | C. W. Janes |
| Armour Inst. of Tech., Chicago, Ill | 5 | E. H. Freeman |
| British Columbia, Univ. of, Vancouver | 10 | W. B. Coulthard |
| Brooklyn, Polytechnic Inst. of, Brooklyn, N. Y. | 3 | A. B. Giordano |
| Brown Univ., Providence, R. I. | 1 | F. N Tompkins |
| Bucknell Univ., Lewisburg, Pa | 2 | J. B. Miller |
| California Inst. of Tech., Pasadena | 8 | F. W. Maxstadt |
| California, Univ. of, Berkeley | 8 | C. F. Dalziel |
| Carnegie Inst. of Technology, Pittsburgh, Pa | 2 | G. R. Patterson |
| Case School of Applied Science, Cleveland, Ohio | 2 | J. R. Martin |
| Catholic Univ. of America, Washington, D. C. | 2 | T. J. MacKavanagh |
| Cincinnati, Univ. of, Cincinnati, Ohio | 2 | L. R. Culver |
| Clarkson Col. of Technology, Potsdam, N. Y. | 1 | A. R. Powers |
| Clemson Agricultural Col., Clemson, S. C. | 4 | S. R. Rhodes |
| Colorado State Col. of A. & M. Arts, Fort Collins | 6 | F. B. Beatty |
| Colorado, Univ. of, Boulder | 6 | H. B. Palmer |
| Columbia Univ., New York, N. Y. | 3 | G. T. Harness |
| Cooper Union, New York, N. Y. | 3 | N. L. Towle |
| Cornell Univ., Ithaca, N. Y. | 1 | W. W. Cotner |
| Denver, Univ. of, Denver, Colo | 6 | Chester Russell, Jr. |
| Detroit, Univ. of, Detroit, Mich | 5 | H. O. Warner |
| Drexel Inst. of Technology, Philadelphia, Pa | 2 | E. O. Lange |
| Duke Univ., Durham, N. C. | 4 | W. J. Seeley |
| Florida, Univ. of, Gainesville | 4 | E. F. Smith |
| George Washington Univ., Washington, D. C. | 2 | A. G. Ennis |
| Georgia School of Technology, Atlanta | 4 | T. W. Fitzgerald |
| Harvard Univ., Cambridge, Mass | 1 | J. D. Cobine |
| Idaho, Univ. of, Moscow | 9 | R. H. Hull |
| Illinois, Univ. of, Urbana | 5 | E. A. Reid |
| Iowa State Col., Ames | 5 | B. S. Willis |
| Iowa, Univ. of, Iowa City | 5 | G. F. Corcoran |
| Johns Hopkins Univ., Baltimore, Md | 2 | W. B. Kouwenhoven |
| Kansas State Col., Manhattan | 7 | R. G. Kloeffler |
| Kansas, Univ. of, Lawrence | 7 | R. J. W. Koopman |
| Kentucky, Univ. of, Lexington | 4 | Brinkley Barnett |
| Lafayette Col., Easton, Pa | 2 | F. W. Smith |
| Lehigh Univ., Bethlehem, Pa | 2 | N. S. Hibshman |
| Lewis Inst., Chicago, Ill | 5 | L. T. Anderson |
| Louisiana State Univ., Baton Rouge | 4 | W. D. Morris |
| Louisville, Univ. of, Louisville, Ky | 4 | J. M. Roberts |
| Maine, Univ. of, Orono | 1 | A. S. Hill |
| Marquette Univ., Milwaukee, Wis | 5 | E. W. Kane |
| Maryland, Univ. of, College Park | 2 | L. J. Hodgins |
| Massachusetts Inst. of Technology, Cambridge | 1 | Gordon S. Brown |
| Michigan Col. of Mining & Tech., Houghton | 5 | G. W. Swenson |
| Michigan State Col., E. Lansing | 5 | M. M. Cory |
| Michigan, Univ. of, Ann Arbor | 5 | J. S. Gault |
| Milwaukee School of Engg., Milwaukee, Wis | 5 | E. L. Wiedner |
| Minnesota, Univ. of, Minneapolis | 5 | J. H. Kuhlmann |
| Mississippi State Col., State College | 4 | H. C. Simrall |
| Missouri School of Mines and Met., Rolla | 7 | J. Stuart Johnson |
| Missouri, Univ. of, Columbia | 7 | R. B. Vaile |
| Montana State Col., Bozeman | 9 | E. W. Schilling |
| Nebraska, Univ. of, Lincoln | 6 | L. A. Bingham |
| Nevada, Univ. of, Reno | 8 | S. G. Palmer |

| Name and Location | District | Counselor (Member of Faculty) |
|---|---|---|
| Newark Col. of Engineering, Newark, N. J. | 3 | C. H. Stephan |
| New Hamsphire, Univ. of, Durham | 1 | L. W. Hitchcock |
| New Mexico State Col., State College | 7 | M. A. Thomas |
| New Mexico, Univ. of, Albuquerque | 7 | R. W. Tapy |
| New York, Col. of the City of, New York | 3 | Harry Baum |
| New York Univ., New York | 3 | H. N. Walker |
| North Carolina State Col., Raleigh | 4 | R. S. Fouraker |
| North Dakota Agricultural Col., Fargo | 6 | H. S. Rush |
| North Dakota, Univ. of, Grand Forks | 6 | H. F. Rice |
| Northeastern Univ., Boston, Mass | 1 | R. G. Porter |
| Northwestern Univ., Evanston, Ill | 5 | E. W. Kimbark |
| Norwich Univ., Northfield, Vt | 1 | D. E. Howes |
| Notre Dame, Univ. of, Notre Dame, Ind | 5 | J. A. Northcott |
| Ohio Northern Univ., Ada | 2 | D. S. Pearson |
| Ohio State Univ., Columbus | 2 | E. E. Kimberly |
| Ohio Univ., Athens | 2 | W. M. Young |
| Oklahoma A. & M. Col., Stillwater | 7 | Albrecht Naeter |
| Oklahoma, Univ. of, Norman | 7 | C. T. Almquist |
| Oregon State Col., Corvallis | 9 | A. L. Albert |
| Pennsylvania State Col., State College | 2 | P. X. Rice |
| Pennsylvania, Univ. of, Philadelphia | 2 | Irven Travis |
| Pittsburgh, Univ. of, Pittsburgh, Pa | 2 | R. C. Gorham |
| Puerto Rico, Univ. of, Mayaguez | 3 | G. F. Anton |
| Pratt Institute, Brooklyn, N. Y. | 3 | D. H. Wright |
| Princeton Univ., Princeton, N. J. | 2 | A. E. Vivell |
| Purdue Univ., Lafayette, Ind | 5 | J. H. Bowman |
| Rensselaer Polytechnic Inst., Troy, N. Y. | 1 | L. C. Holmes |
| Rhode Island State Col., Kingston | 1 | W. B. Hall |
| Rice Institute, Houston, Texas | 7 | J. S. Waters |
| Rose Polytechnic Inst., Terre Haute, Ind | 5 | C. C. Knipmeyer |
| Rutgers Univ., New Brunswick, N. J. | 3 | F. P. Fischer |
| Santa Clara, Univ. of, Santa Clara, Calif | 8 | E. F. Peterson |
| South Carolina, Univ. of, Columbia | 4 | T. F. Ball |
| South Dakota State Col., Brookings | 6 | W. H. Gamble |
| South Dakota State School of Mines, Rapid City | 6 | L. O. Kammerman |
| Southern California, Univ. of, Los Angeles, Calif | 8 | J. K. Nunan |
| Southern Methodist Univ., Dallas, Texas | 7 | S. G. Lutz |
| Stanford Univ., Stanford University, Calif | 8 | H. H. Skilling |
| Stevens Inst. of Technology, Hoboken, N. J. | 3 | H. C. Roters |
| Swarthmore Col., Swarthmore, Pa | 2 | J. D. McCrumm |
| Syracuse Univ., Syracuse, N. Y. | 1 | C. W. Henderson |
| Tennessee, Univ. of, Knoxville | 4 | J. G. Tarboux |
| Texas A. & M. Col., College Station | 7 | N. F. Rode |
| Texas Technological Col., Lubbock | 7 | W. F. Helwig |
| Texas, Univ. of, Austin | 7 | R. A. Galbraith |
| Tufts Col., Tufts College, Mass | 1 | E. A. Walker |
| Tulane Univ., New Orleans, La | 4 | C. B. Norris |
| Union Col., Schenectady, N. Y. | 1 | J. E. Paul |
| Utah, Univ. of, Salt Lake City | 9 | F. L. Poole |
| Vermont, Univ. of, Burlington | 1 | E. R. McKee |
| Villanova Col., Villanova, Pa | 2 | H. S. Bueche |
| Virginia Military Inst., Lexington | 4 | J. S. Jamison |
| Virginia Polytechnic Inst., Blacksburg | 4 | Claudius Lee |
| Virginia, Univ. of, University | 4 | L. R. Quarles |
| Washington, State Col. of, Pullman | 9 | H. F. Lickey |
| Washington, Univ. of, Seattle | 9 | R. E. Lindblom |
| Washington Univ., St. Louis, Mo | 7 | H. G. Hake |
| West Virginia Univ., Morgantown | 2 | A. H. Forman |
| Wisconsin, Univ. of, Madison | 5 | R. R. Benedict |
| Worcester Polytechnic Inst., Worcester, Mass | 1 | V. Siegfried |
| Wyoming, Univ. of, Laramie | 6 | G. H. Sechrist |
| Yale Univ., New Haven, Conn | 1 | A. G. Conrad |

Total..........122

# Local Sections of the Institute

| Name | District | When Organized | Membership Aug. 1, 1940 | Chairman | Secretary | Secretary's Address |
|---|---|---|---|---|---|---|
| Akron | 2 | Aug. 12, '20 | 85 | F. A. Green | H. L. Rorden | Ohio Brass Co., Barberton, Ohio |
| Alabama | 4 | May 22, '29 | 40 | T. H. Mawson | W. W. R. Purcell | Alabama Power Co., Birmingham, Ala. |
| Boston | 1 | Feb. 13, '03 | 415 | R. W. Adams | W. I. Middleton | Simplex Wire and Cable Co., Cambridge, Mass. |
| Central Indiana | 5 | Jan. 12, '12 | 132 | R. A. Scholl | B. T. Loeffler | Indiana Bell Telphone Co., Indianapolis, Ind. |
| Chicago | 5 | 1893 | 769 | F. V. Smith | K. V. Glentzer | Illinois Bell Telephone Co., Chicago, Ill. |
| Cincinnati | 2 | June 30, '20 | 207 | C. F. Lee | H. E. Barnett | Cincinnati and Suburban Bell Telephone Co., Cincinnati, Ohio |
| Cleveland | 2 | Sept. 27, '07 | 332 | L. C. Porter | Wm. R. Hough | Reliance Electrical and Engineering Co., Cleveland, Ohio |
| Columbus | 2 | Mar. 17, '22 | 93 | F. A. Teach | D. E. Stafford | National Electric Coil Co., Columbus, Ohio |
| Connecticut | 1 | Apr. 16, '21 | 279 | T. J. Russell | A. G. Conrad | Yale University, New Haven, Conn. |
| Denver | 6 | May 18, '15 | 192 | W. G. Rubel | J. R. Walker | U. S. Bureau of Reclamation, Denver, Colo. |
| East Tennessee | 4 | Sept. 2, '36 | 132 | J. G. Tarboux | J. D. Harper | Aluminum Company of America, Alcoa, Tenn. |
| El Paso | 7 | Mar. 7, '40 | 47 | I. W. Best | F. A. Decker | College of Mines and Metallurgy, El Paso, Texas |
| Erie | 2 | Jan. 11, '18 | 57 | J. D. Heibel | W. D. Bearce | 4121 Sassafras St., Erie, Pa. |
| Florida | 4 | Jan. 28, '31 | 78 | H. J. B. Scharnberg | Joseph Weil | University of Florida, Gainesville, Fla. |
| Fort Wayne | 5 | Aug. 14, '08 | 109 | Wayne Kehoe | G. C. Harvey | General Electric Co., Fort Wayne, Ind. |
| Georgia | 4 | Jan. 14, '04 | 109 | E. H. Bailey | J. M. Flanigen | Georgia Power Co., Atlanta, Ga. |
| Houston | 7 | Aug. 7, '28 | 141 | L. H. Matthes | P. H. Underwood | P. O. Box 1700, Houston, Tex. |
| Iowa | 5 | June 25, '29 | 72 | H. H. Brown | G. R. Corcoran | State University of Iowa, Iowa City, Iowa. |
| Ithaca | 1 | Oct. 15, '02 | 51 | M. G. Northrop | John P. Wood | Cornell University, Ithaca, N. Y. |
| Kansas City | 7 | Apr. 14, '16 | 148 | P. C. Ellis | G. K. Shirling | Southwestern Bell Telephone Co., Kansas City, Mo. |
| Lehigh Valley | 2 | Apr. 16, '21 | 191 | W. J. D. Geary | J. E. Treweek | Pennsylvania Power and Light Co., Hazleton, Pa. |
| Los Angeles | 8 | May 19, '08 | 506 | J. M. Gaylord | T. M. Blakeslee | Bureau of Power and Light, Los Angeles, Calif. |
| Louisville | 4 | Oct. 15, '26 | 61 | J. F. Miller | J. R. Smith | Louisville Gas and Electric Co., Louisville, Ky. |
| Lynn | 1 | Aug. 22, '11 | 147 | L. P. Shildneck | J. H. Goss | General Electric Co., Bldg. 2-M., Lynn, Mass. |
| Madison | 5 | Jan. 8, '09 | 67 | H. J. Kubiak | F. A. Maxfield | University of Wisconsin, Madison, Wis. |
| Mansfield | 2 | Mar. 6, '39 | 68 | W. B. Johnson | H. O. Whitely | North Electric Manufacturing Co., Galion, Ohio |
| Maryland | 2 | Dec. 16, '04 | 252 | C. S. Fiske | H. J. Casey | Baltimore Transit Co., Baltimore, Md. |
| Memphis | 4 | May 23, '30 | 72 | E. J. Biegel | W. M. Brewer, Jr. | Memphis Light, Gas and Water Division, Memphis, Tenn. |
| Mexico | 3 | June 29, '22 | 56 | C. Santacruz | C. C. Jagou | Apartado 2966, Mexico City, Mexico |
| Michigan | 5 | Jan. 13, '11 | 376 | E. V. Sayles | S. M. Dean | Detroit Edison Co., Detroit, Mich. |
| Milwaukee | 5 | Feb. 11, '10 | 280 | R. R. Ranson | G. W. Clothier | Allis-Chalmers Manufacturing Co., Milwaukee, Wis. |
| Minnesota | 5 | Apr. 7, '02 | 107 | R. E. Burlingame | H. E. Hartig | University of Minnesota, Minneapolis, Minn. |
| Montana | 9 | June 24, '31 | 36 | E. W. Schilling | Herold Murdock | The Montana Power Co., Bozeman, Mont. |
| Muscle Shoals | 4 | Feb. 18, '38 | 33 | B. M. Anthony | J. P. Hamilton | Box 783, East Florence, Ala. |
| Nebraska | 6 | Jan. 21, '25 | 48 | L. A. Bingham | John M. Gibb | 504 City Hall, Omaha, Nebr. |
| New Orleans | 4 | Dec. 8, '33 | 123 | E. B. Mabson | F. E. Johnson | 317 Baronne St., New Orleans, La. |
| New York | 3 | Dec. 10, '19 | 3,346 | J. F. Fairman | C. C. Whipple | Polytechnic Inst. of Brooklyn, Brooklyn, N. Y. |
| Niagara Frontier | 1 | Feb. 10, '25 | 197 | G. W. Eighmy | Wm. K. Parks | Westinghouse Electric and Manufacturing Co., Buffalo, N. Y. |
| North Carolina | 4 | Mar. 21, '29 | 91 | Albert Milmow | G. O. Bason | 107 Latta Arcade, Charlotte, N. C. |
| North Texas | 7 | May 18, '28 | 170 | H. R. Pearson | G. N. Pingree | General Electric Co., Dallas, Tex. |
| Oklahoma City | 7 | Feb. 16, '22 | 117 | W. B. Stephenson | John Shawver | Oklahoma Gas and Electric Co., Oklahoma City, Okla. |
| Philadelphia | 2 | Feb. 18, '03 | 650 | D. C. Prince | W. B. Morton | Philadelphia Electric Co., Philadelphia, Pa. |
| Pittsburgh | 2 | Oct. 13, '02 | 564 | G. R. Patterson | R. L. Dunlap | Bell Telephone Co. of Pa., Pittsburgh, Pa. |
| Pittsfield | 1 | Mar. 25, '04 | 192 | E. V. DeBlieux | M. E. Scoville | General Electric Co., Pittsfield, Mass. |
| Portland | 9 | May 18, '09 | 176 | J. A. Hooper | D. L. Brown | Portland General Electric Co., Portland, Ore. |
| Providence | 1 | Mar. 12, '20 | 99 | H. A. Baines | O. E. Sawyer | 56 Friendly Road, Auburn, R. I. |
| Rochester | 1 | Oct. 9, '14 | 103 | Wm. F. Cotter | C. F. Harris | Westinghouse Electric and Manufacturing Co., Rochester, N. Y. |
| St. Louis | 7 | Jan. 14, '03 | 273 | L. L. Crump | J. S. Malsbary | Wagner Electric Co., St. Louis, Mo. |
| San Antonio | 7 | May 23, '30 | 45 | N. B. Gussett | W. F. Pinckert | 203 Elmhurst St., San Antonio, Tex. |
| San Diego | 8 | Jan. 18, '39 | 36 | W. L. Bryant, Jr. | B. B. Gravitt | General Electric Co., San Diego, Calif. |
| San Francisco | 8 | Dec. 23, '04 | 507 | C. V. Fowler | B. L. Robertson | University of California, Berkeley, Calif. |
| Saskatchewan | 10 | Oct. 14, '25 | 15 | B. J. O. Strong | W. E. Bolton | 2339 Garnet St., Regina, Sask., Can. |
| Schenectady | 1 | Jan. 26, '03 | 434 | E. M. Hunter | T. T. Woodson | General Electric Co., Research Laboratory, Schenectady, N. Y. |
| Seattle | 9 | Jan. 19, '04 | 164 | G. R. Shuck | C. H. Cutter | Pacific Electric Manufacturing Co., Seattle, Wash. |
| Sharon | 2 | Dec. 11, '25 | 105 | C. L. Knotts | H. R. Arnold | Westinghouse Electric and Manufacturing Co., Sharon, Pa. |
| South Carolina | 4 | Mar. 2, '40 | 37 | T. F. Ball | S. R. Rhodes | Clemson College, Clemson, S. C. |
| Spokane | 9 | Feb. 14, '13 | 81 | H. B. Hodgins | H. J. Reeves | North 3627 Audubon St., Spokane, Wash. |
| Springfield | 1 | June 29, '22 | 57 | H. D. Griffith | Isaiah Creaser | 76 Cortland St., Springfield, Mass. |
| Syracuse | 1 | Aug. 12, '20 | 75 | E. A. Gruppe | V. J. Brown | 157 Shotwell Park, Syracuse, N. Y. |
| Toledo | 2 | June 3, '07 | 71 | H. R. Daykin | W. M. Campbell | 2145 Central Grove Ave., Toledo, Ohio |
| Toronto | 10 | Sept. 30, '03 | 342 | J. M. Thomson | F. C. Barnes | Canadian General Electric Co., Ltd., Toronto, Ont., Can. |
| Tulsa | 7 | Oct. 1, '37 | 94 | H. P. Dougherty | J. V. McGinity | American Steel and Wire Co., Tulsa, Okla. |
| Urbana | 5 | Nov. 25, '02 | 76 | H. H. Horn | L. B. Archer | University of Illinois, Urbana, Ill. |
| Utah | 9 | Mar. 9, '17 | 76 | O. C. Haycock | J. A. McDonald | General Electric Co., 200 S. Main St., Salt Lake City, Utah. |
| Vancouver | 10 | Aug. 22, '11 | 97 | J. H. Steede | E. O. Lunn | 150 Cordova St., Vancouver, B. C., Can. |
| Virginia | 4 | May 19, '22 | 111 | C. L. Crosby | Llewellyn Saunders | 1042 Jamestown Crescent, Norfolk, Va. |
| Washington | 2 | Apr. 9, '03 | 370 | J. E. O'Brien | W. J. Ellenberger | Potomac Electric Power Co., Washington, D. C. |
| West Virginia | 4 | Apr. 9, '40 | 48 | E. B. Snyder | D. L. Gunter | Appalachian Electric Power Co., Charleston, W. Va. |
| Wichita | 7 | Sept. 16, '37 | 52 | P. S. Colby | R. B. Gow | Kansas Gas & Electric Co., Wichita, Kans. |
| Worcester | 1 | Feb. 18, '20 | 63 | A. H. Magnuson | W. W. Locke, Jr. | Worcester Polytechnic Institute, Worcester, Mass. |
| Total | 70 | | | | | |

# Of Current Interest

## Foster Parents Needed for Child Refugees

*The following message is addressed to AIEE members by Marshall Field, president of the United States Committee for the Care of European Children, Inc.*

With the increasing seriousness of the situation in Great Britain, steps for the evacuation of children to the United States are taking concrete form. The British Government, forced to postpone its own evacuation plans because of the critical need for its naval strength at home, has 200,000 children voluntarily registered for departure overseas. Of this number it is hoped that about 50,000 will come to the United States, and immigration visas for some 3,000 have already been cleared with the Department of State.

Responsible for America's hospitality to these children is the United States Committee for the Care of European Children. This is the organization officially recognized by the United States Government and British authorities as the agency co-ordinating the efforts of all social-welfare groups in this country prepared to aid in the task. Its function is to clear the paths for the admission here of as many refugee children as possible and to see that they are adequately provided for. Transportation facilities on the other side are being arranged by a co-operating group, the American Committee for the Evacuation of British Children, organized under the sponsorship of United States Ambassador Joseph J. Kennedy.

The most pressing need in the United States, in addition to that for funds, is for foster homes. Thus far, some 7,000 American families have opened their doors. Prospective foster parents offering full support are required by government regulation to submit an affidavit, which varies in detail. The foster parent must guarantee that the child will not become a public charge, that his care will at all times be in accordance with the standards of the Children's Bureau of the Department of Labor and subject to supervision by a local child-care agency designated by the United States Committee. Income must be stipulated; a credit investigation will be made and evidence requested to support the affidavit. However, individuals will be spared the considerable trouble which attends immigration, for the United States Government has agreed to accept the corporate affidavit of the United States Committee, based on the collective assurances of individuals, guaranteeing the proper care of the children while they are here and setting aside the sum of \$50 for each child as a trust fund to be held as a safeguard against future contingencies.

The children coming here will all be under 16, from all types of homes representing all religions and backgrounds. Where conditions permit, French, Polish, Dutch, Belgian, and other children will be included. Their stay is limited to two years and each child must have a home abroad to which he can return at the end of the war. Of those now expected here, none will have friends or relatives in this country. British children may not be legally adopted in the United States as that is contrary to British law. If the child should lose his father and mother in the war, the American foster parents will have no added responsibility.

All children will be given medical examinations both on the other side and here. They will be expected to attend school until they are 16. About 150 private schools have volunteered to maintain groups of boys or girls free or at reduced tuition.

Funds are needed at once for the support of children for whom suitable foster homes are available but in families unable to afford the expense; and for the shelter and care of arriving children pending their placement. The United States Committee has launched a national campaign for \$5,000,000 to carry on its job.

Members of the AIEE are invited to lend their homes for the duration either for full or partial support of one or more children. More complete details may be obtained from the United States Committee for the Care of European Children, 215 Fourth Avenue, New York, N. Y.

## From A E C • •

ITEMS appearing under this heading are from the news service of American Engineering Council.

### New Executive Secretary Appointed

Colonel L. B. Lent, well known as an engineer, inventor, and trade association executive, has been appointed executive secretary of AEC, succeeding Frederick M. Feiker (M'34) who resigned several months ago to become dean of engineering at George Washington University. Colonel Lent is a native of Brewster, N. Y., and a graduate of Stevens Institute of Technology, Hoboken, N. J. After five years as associate editor of *Power* his studies of gas-engine development led to an association with the Riverside Engine Company, Oil City, Pa. The installation by this firm of several large engines for the Ford Motor Company resulted in his employment by that company as assistant chief engineer of construction and maintenance.

As an inventor, Colonel Lent secured patents on a motor pumper type of fire engine and founded a company to manufacture these units. The World War, however, abruptly terminated this activity. Entering the Army, he was assigned to the development of airplane engines at the Curtiss plant in Buffalo, N. Y., subsequently being transferred to Langley Field, Va., as engineer officer, and later to Camp Vail, N. J., as commanding officer of Air Service troops at that field. Later, he had command at Brindley Field and Roosevelt Field.

After the war he became superintendent of the United States Air Mail Service and played a prominent part in the development of the early routes connecting Chicago with St. Louis, Minneapolis, and San Francisco and organized the first transcontinental service from New York to San Francisco.

Colonel Lent entered trade association work as chief engineer of the Common Brick Manufacturers' Association of America. He later became executive officer of the Scientific Apparatus Makers Association, writing and administering the NRA code for the 500 members of this industry. He was then made president of the Panoptik Company, which administered a patent licensing plan in the field of optical products. More recently he has been a consultant in the aviation field, especially as engineer to the Aeronautical Development Commission of the State of Connecticut.

### Goals in National Defense

Approval by Congress of an expanded United States Navy exceeding in size the combined present fleets of Great Britain and Japan, announcement of the financing of a new plant that will double present production of high-power aviation engines, and assurances from William S. Knudsen of the National Defense Advisory Commission that the United States has the industrial ability to equip a force of 2,000,000 fighting men, were high spots of an eventful month in Washington.

The rapidity with which the armament program is being accelerated may be gauged from Mr. Knudsen's report that between June 6 and July 25 contracts were cleared aggregating \$1,412,807,678 for the Navy and an additional \$315,288,152 for the Army. As pointed out by Mr. Knudsen, *contract awards are far removed from finished goods*, and there are many problems of production still to be solved.

Few persons realize the complexity of the task of supplying a modern army and navy. Unofficial estimates place the number of needed articles at 70,000, of which all but some 3,700 are commercially manufactured. Most of these latter can be manufactured in existing plants at the cost of some disturbance to normal operations, and it is this type of article that has been the subject of recent "educational orders" placed to accustom selected manufacturers to quantity production when this becomes necessary. During recent years the War Department has inspected 20,000 commercial plants to procure definite knowledge of their equipment and capacity, and has assigned

definite products to 10,340 of these. There still remain, however, some 200 critical items requiring highly specialized equipment or methods not applicable to peacetime uses, and these must be produced in Government-owned plants. Thus the Army's plans for a major military emergency include the erection of 78 ordnance, 28 chemical, and 2 quartermaster plants at a total cost of more than $600,000,000. Congress already has earmarked approximately this amount for such construction. (W. H. Harrison, AIEE past-president, recently was appointed to serve as the Commission's director of new plant construction.)

Aside from the building of this type of plant, there is sure to be considerable expansion of private facilities, particularly in the aviation industry. Not only is the United States determined to build up its own air forces, but the British have announced their desire to buy planes at the rate of 3,000 per month for the next two years, and their willingness to finance the plant expansion necessary to attain this goal. The first defense-plant construction loan to be approved by the Reconstruction Finance Corporation was for a $92,000,000 plant for the Wright Aeronautical Corporation to be located near Cincinnati, Ohio. This will turn out 12,000 airplane motors annually, virtually doubling present American production capacity.

#### ADVISORY COMMITTEES NAMED

To avoid overloading the construction industry in any one locality and to provide general co-ordination and advice on plant and construction problems, the Army and Navy Munitions board has appointed a civilian committee of construction experts with the following members:

Colonel John P. Hogan, president, American Society of Civil Engineers, *chairman;* Alonzo J. Hammond, president, American Engineering Council; E. J. Harding, general manager, Associated General Contractors of America; E. P. Palmer, past president of the Associated General Contractors; Malcolm Pirnie, chairman of the Construction League; Stephen F. Voorhees, past president of the American Institute of Architects.

A second committee of civilian experts has been named by the War Department to speed up the negotiation of construction contracts. This advisory section will recommend, for each building job, three firms which appear best qualified to perform the work; the Department then will attempt to negotiate a contract with one of these on a cost-plus-fixed-fee basis. Appointments to the committee so far are: Francis Blossom, of Sanderson and Porter, New York; Forrest S. Harvey, recently with Lee, Hill, Barnard, and Jowett, Los Angeles; and F. J. C. Dresser, Cleveland, director of the American Construction Council. Two other members are yet to be named.

#### TVA EXPANDED

At the request of the Defense Commission, Congress has appropriated $25,000,000 to begin a $65,000,000 expansion program by the Tennessee Valley Authority which will provide additional power facilities "for the production of aluminum and other defense materials in its territory." Included will be a new dam on the Holston River, an auxiliary steam generating station, and additional hydroelectric generating units at Wilson and Pickwick Landing Dams.

#### TAX-REVISION BARRIER CAUSES DELAY

Expansion of privately owned plants currently is being delayed by pending revisions of the tax laws. The Defense Commission long ago pointed out that manufacturers could not be expected to invest large sums in new plant and equipment that might be rendered unusable by the negotiation of an unexpected peace, and suggested that one acceptable way of cushioning this risk would be to permit the new facilities to be amortized in five years instead of ten. This change in income tax practice could be effected by a simple amendment by Congress, and this procedure is recommended. Congressional leaders, however, insisted upon the political advisability of considering this change together with pending legislation imposing excess profits taxes and revising the restrictions on profits from shipbuilding and aircraft contracts, with the result that the plant construction program is in suspense until this complicated situation can be debated and disposed of.

#### NAVY INCREASED 70 PER CENT

In authorizing an unprecedented increase in the size of the Navy, Congress embarked upon a construction program that will mean the annual expenditure of $2,000,000,000 for construction until 1947. How this will expand the fleet is indicated in the following table:

| Category | Now in Service | Now Under Construction | Ultimate Strength |
|---|---|---|---|
| Battleships | 15 | 10 | 35 |
| Airplane carriers | 6 | 5 | 20 |
| Cruisers | 37 | 21 | 88 |
| Destroyers | 236 | 61 | 378 |
| Submarines | 101 | 41 | 180 |
| Total | 395 | 138 | 701 |

To meet this heavy construction schedule considerable expansion in shipbuilding facilities will be required, and $150,000,000 is authorized for this purpose.

## Migrant Labor Problems

Economic and social questions arising from maladjustments between the supply of and demand for migratory labor are currently being studied by a Congressional committee which, during the next four months, will hold hearings and view conditions in all parts of the United States, with the purpose of recommending remedial legislation to the next Congress.

The magnitude of this question is pointed out by a recent report made to the President by an interdepartmental committee to co-ordinate health and welfare activities of the Federal Government. It estimates that there are now 2,000,000 persons without fixed habitations looking to agriculture for a living, and at least an equal number dependent upon industry. More than half of the 48 states are directly affected. Remedial steps recommended include:

1. Federal-state co-operation to accelerate the collection and study of information, and to promote public understanding of the problem.

2. Federal aid for educational, recreational, and welfare services in communities affected.

3. More Federal camps for migratory agricultural labor.

4. A Federal-state program to provide them with health and medical services.

5. Closer Federal regulation of labor-recruiting activities and the extension of wage-hour and social-security benefits to migrants.

## Havana Parley

Co-operation among the 21 republics of the western hemisphere, which has been increasing steadily since the outbreak of war in Europe, attained new heights as the result of a successful conference on economic and military problems held in Havana late in July. The discussions centered around three principal problems, all closely related to the war. Decisions were reached as follows:

1. Supporting recent United States affirmations regarding the Monroe Doctrine, it was decided that rather than to permit the exchange of colonies in the western hemisphere from one European nation to another, such territory will be taken over and governed temporarily by a joint committee representing all American nations, and eventually either given an independent status or returned to its original jurisdiction. In an emergency it becomes "the right and duty" of any one or more signatories to take action to prevent any such transfer. In effect, this means general acceptance of the Monroe Doctrine and the granting of blanket permission to the United States to enforce it without incurring the old charge of "imperialism."

2. All signatories agreed freely to exchange information on propaganda or "fifth column" activitie and to develop standards defining the legitimate activities of diplomatic and consular officials.

3. To meet current disruption of international trade and possible future attempts to use it as a method of political warfare, it was agreed to strengthen and expand present facilities for stimulating inter-American trade and increasing consumption within the hemisphere in all possible ways.

## Pan-American Relations

Responding to an invitation by the Department of State, Colonel L. B. Lent, new executive secretary of American Engineering Council, and C. O. Bickelhaupt (M'22, F'28), chairman of its committee on inter-American engineering relations, conferred August 1 with C. A. Thomson, H. H. Pierson, and Richard Pattee, of the Division of Cultural Relations, relative to specific methods by which the committee can lend its advice and assistance to the State Department. The discussion centered about facilities for the introduction to the profession of engineers arriving from abroad, specifically the eight Latin-American students soon to arrive in this country to attend the Farm Equipment Seminar, as well as others expected to come later under the exchange plan now being inaugurated. The committee also was asked to consider the problem of securing applications from qualified engineering teachers for exchange professorships under this same plan, for which funds are now available.

The State Department has asked Council to broadcast the information that many requests are being received from abroad for informative educational motion picture films reflecting the life, ideals, and customs of the United States. While a certain number of government films are available, the

Department could meet these requests more adequately if it had available for distribution films of this type produced by other than government agencies, and it is hoped that these will be made available by those who have them.

## Plan Board Surveys U. S.

Facts and figures regarding many factors entering into the trend of American life are gathered together in a recent report of the National Resources Planning Board. Topics considered include population trends and their effects, national income, transportation, agriculture, national resources, education, and public works. Some of the conclusions reached are:

1. U. S. population will increase to 158,000,000 by 1980, thereafter remain stationary or decline. Between 1935 and 1975 the number of persons aged 20 to 44 will increase by only 6 per cent, while those in the age group 45 to 64 will increase 69 per cent. Enrollment in schools and colleges will increase for several years, then level off.

2. Planning on a national scale is necessary to make the most effective use of resources in many fields. For example, conflicts among railroads, highways, airways, waterways, and pipe lines result in unnecessary duplications of service and high costs to the general public.

3. Research activities of various government agencies should be co-ordinated to avoid confusion and undue expense.

4. To provide medical service to the one-third of the population that is classed in the lowest income bracket (under $750 per year) would cost $850,000,000 annually. Economic losses attributable to illness and premature death are estimated now at 10 billion dollars annually.

## PWA Starts Liquidation

After seven years of operation in the financing and supervision of construction projects in all parts of the country, the Public Works Administration is now engaged in winding up its affairs under the Congressional mandate that it be completely liquidated by July 1, 1941. Personnel, which reached a peak of 10,400 persons when the last (1938) program was in full swing, is now down to 2,331, including over 500 engineers, and further reductions are being made rapidly.

## Portable Generators for REA Projects

Diesel-electric generating station units mounted on trailers will be used to supply power for at least three rural electric systems financed through the Rural Electrification Administration, according to a recent announcement. Two such units are now going into service for the Jo-Carroll Electric Cooperative, an Illinois organization supplying 600 families through 278 miles of line, and the purchase of similar units has been authorized for two other REA projects in Oregon.

One of the latter projects centers about the town of Jordan Valley, located 25 miles from the nearest available source of electricity. The other two projects have been unable to buy power at low rates and are therefore resorting to this method of supplying power during the initial load-building period, with the idea of making more permanent arrangements after their loads become stabilized.

Each portable unit consists of two Diesel-powered generators of 60- and 40-kw capacity, respectively, mounted upon a rubber-tired trailer. No building is required to house them and they may be connected to the power line at any convenient point through step-up transformers. Operation is semiautomatic, requiring only the part-time attention of one man.

# Industry • • • •

## Electrical Engineering Exposition to Be Held in Philadelphia

An Electrical Engineering Exposition will be held in Convention Hall, Philadelphia, Pa., January 27–31, 1941, during the same week as the AIEE winter convention, which also takes place in Philadelphia. The Exposition, said to be the first of its kind ever held, is designed to serve the electrical industry by promoting a more rapid dissemination of information on new developments in electrical engineering. Exhibits will include new and improved electrical products for the generation, transmission, and utilization of electric energy.

Members of the advisory committee of the exposition are:

J. T. Barron (A'07, F'27) vice-president, Public Service Electric and Gas Company, Newark, N. J.; Walter S. Finlay, Jr. (A'18, F'21) vice-president, J. G. White, Engineering Corporation, New York, N. Y.; E. S. Fitz (A'16, M'32) general manager, electrical department, Virginia Electric and Power Company, Richmond; N. E. Funk (A'07, F'34) vice-president, Philadelphia (Pa.) Electric Company (chairman, AIEE 1941 winter convention committee); C. W. Leihy (A'30, M'38) editor, *Electric Light and Power*, Electrical Publications, Inc., Chicago, Ill.; A. L. Pennimann, Jr. (A'15, M'32) general superintendent, electric operations, Consolidated Gas, Electric Light and Power Company of Baltimore, Md.; W. A. Perry (M'38) superintendent, electric and power departments, Inland Steel Company, East Chicago, Ind.; R. C. Roe (A'18, F'33) president, Burns and Roe, Inc., New York, N. Y.; Charles F. Roth, manager, exposition; E. K. Stevens, manager, exposition; R. W. Wilbraham (M'21) chief electrical engineer, United Engineers and Constructors, Inc., Philadelphia, Pa.; S. B. Williams (M'37) editor, *Electrical World*, McGraw-Hill Publishing Company, New York, N. Y.

The exposition is being sponsored by International Exposition Company, Grand Central Palace, New York, N. Y., which also conducts the National Power Show, the Exposition of Chemical Industries, and the International Heating and Ventilating Exposition.

**Transmitting Station.** A new 50,000-watt air-cooled transmitting station for Westinghouse radiobroadcasting station WBZ, Boston, Mass., recently was put into operation at Hull, Mass., across the harbor from Boston. Although the new transmitter has the same power output as the former one, the use of a directive antenna is expected greatly to extend its range. The transmitting station was opened with network ceremonies that included the splitting of an atom of uranium, by means of which power was switched to the new station.

## Fluorescent Lighting for Offices

One of the most comprehensive commercial installations yet made of fluorescent lighting is being tried in a large Philadelphia building. The try-out is of interest not only to illuminating engineers, but also to office-building managers, because it represents the first attempt to make this type of lighting a major attraction in leasing office space.

The experiment is being carried out in the Broad Street Station Building of the Pennsylvania Railroad, where five offices on the tenth floor—two of them presenting unusual problems because they are inside rooms without windows—have been provided with the new lighting, installed in each case in ceiling fixtures. A different type of installation has been used in each of the five rooms, developed to produce substantially uniform lighting intensity of 20 foot-candles or more at the working plane. The two inside rooms also have been equipped by the designer with "illusion" windows, having Venetian blinds and draperies so arranged that concealed fluorescent tubes along the sides create the appearance of subdued sunlight streaming in behind the curtain.

**Utility to Use "FM."** Frequency-modulation radio communication is being used for an emergency communications system being installed by Indianapolis Power Company, Indianapolis, Ind. The company is equipping ten service cars and trucks with 25-watt mobile transmitters and receivers for two-way communication, enabling the vehicles to be in constant contact with main headquarters, where a 250-watt station transmitter will be in operation. The 25-watt frequency-modulated transmitters are expected to give service over a greater area than was reached by the best of previous 250-watt amplitude-modulated transmitters.

**New Generating Station.** Consumers Power Company's new steam power plant, the John C. Weadock Station, Bay City, Mich., which was dedicated June 20, 1940, has a capacity of 35,000 kw, furnished by the first of two hydrogen-cooled turbine generators. Furnace and boiler for the second unit, which will bring the capacity to 70,000 kw, have been built into the plant. The unit now in operation is a 21-stage tandem-compound turbine designed for a steam pressure of 800 pounds per square inch and a steam temperature of 850 degrees Fahrenheit, and operating at 3,600 rpm.

**Synthetic Rubber.** Formation of the Hydrocarbon Chemical and Rubber Company for the production of synthetic rubber was recently announced by the B. F. Goodrich Company and the Phillips Petroleum Company. "The close co-ordination between the two companies will hasten the day when, if necessary, every American tire, as well as the thousands of other rubber products, can be made wholly with American rubber," a joint statement declared.

**"Telephone of Tomorrow."** Demonstration of an operating unit combining telephone and television equipment is part of

the "previews of progress" shown this year in the General Motors exhibit at the New York World's Fair. The apparatus consists of a standard portable television transmitter connected by co-axial cable with a 12-inch-screen experimental television receiver. A push-button telephone is co-ordinated with the television circuit so that when the telephone instrument is lifted at the receiving end, the image of the person answering flashes on the screen.

# Other Societies

## Engineering Jobs Abundant in Detroit

Many engineering positions reported to the Detroit office of the Engineering Societies Personnel Service, Inc., since its opening July 1, are unfilled because of lack of registrants, the Service reports. Engineering societies participating in the Service are being asked to call this fact to the attention of their members in the Detroit area, so that those who are unemployed or wish to change to a better position may register immediately in person or by mail. It is expected that a great many more positions in all fields of engineering will become available in September with the start of production on the 1941 automobiles and on government contracts for national-defense material.

## Future Meetings of Other Societies

**American Gas Association.** October 7–10, 1940, Atlantic City, N. J.

**American Institute of Mining and Metallurgical Engineers.** Joint meeting, AIME Coal Division, ASME Fuels Division, November 7–9, 1940, Birmingham, Ala.

**American Institute of Physics.** Conference on applied nuclear physics, with Massachusetts Institute of Technology, October 28–November 2, 1940, Cambridge, Mass.

**American Physical Society.** 237th meeting, November 22–23, 1940, Chicago, Ill.

238th meeting, December 1940, Pasadena, Calif.

239th meeting (annual meeting), December 26–28, 1940, Philadelphia, Pa.

**American Society of Civil Engineers.** Fall meeting, October 16–18, 1940, Cincinnati, Ohio.

**American Society of Heating and Ventilating Engineers.** Fall meeting, October 14–15, 1940, Houston, Tex.

**American Society of Mechanical Engineers.** Fall meeting, September 3–6, 1940, Spokane, Wash.

Annual meeting, December 2–3, 1940, New York, N. Y.

**American Transit Association.** 59th annual convention, September 23–26, 1940, White Sulphur Springs, W. Va.

**American Welding Society.** Annual meeting, October 20–25, 1940, Cleveland, Ohio.

**Association of Iron and Steel Engineers.** Annual convention, September 24–27, 1940, Chicago, Ill.

**Conference on Electrical Insulation (National Research Council).** October 31–November 2, 1940, Washington, D. C.

**Electrochemical Society.** Fall meeting, October 2–5, 1940, Ottawa, Canada.

**Engineers' Council for Professional Development.** Annual meeting, October 24, 1940, Pittsburgh, Pa.

**National Electrical Contractors Association.** Fall meeting, October 21–23, 1940, Jacksonville, Fla.

**National Electrical Manufacturers Association.** Annual meeting, October 27–November 1, 1940, New York, N. Y.

**American Society for Metals.** National Metal Congress. October 20–25, 1940, Cleveland, Ohio.

**National Safety Council.** October 7–11, 1940, Chicago, Ill.

**Society of Automotive Engineers.** National aircraft production meeting, October 31–November 2, 1940, Los Angeles, Calif.

## SPEE Surveys Undergraduate Promise

Among papers presented at the annual convention of the Society for the Promotion of Engineering Education at the University of California, June 24–28, 1940, were three reports of the co-ordinated committees on personal development. These were "What Industry Considers Promising Material," "Exploring Promise in the Undergraduate," and "Discovery of Promising Freshman Engineers."

The first report, by the committee headed by Professor John R. Bangs, Cornell University, stressed particularly the growing sensitivity of industry to the necessity of character and proper personality in addition to scholastic and academic advancement. The report placed a considerably responsibility on the engineering colleges for the development of character and desirable personal qualities.

The second report, by Doctor Edward K. Strong, Jr., Stanford University, stressed some of the possibilities of discovering and exploring promising human material, from which to develop engineers. The report indicated that every means at present known to modern science, particularly psychology and statistics, is being used to select students and guide them in the choice of a profession or life work.

The last report, of the committee headed by Doctor R. L. Sackett, showed the participation of engineers in high-school counseling of those boys who want to know what engineering is and pointed out the higher standards for admission to engineering schools as compared with practice ten years ago. Sentiment toward seeking an inventory of student personality and character, rather than scholarship only, in selecting those admitted, is seen to be growing, though only in embryo at present. A larger variety of tests is being used as an aid in selection of students or in the guidance of those who are not progressing satisfactorily. The percentage dropped because of poor performance in engineering education is decreasing as a result of better guidance and selection. As a result, the percentage of graduates shows signs of increasing.

# Letters to the Editor

**INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers; publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.**

## A Transformation Extending the Use of Heaviside's Operational Calculus

*To the Editor:*

Heaviside's operational calculus is based essentially on zero initial charges and currents in the networks being studied. Such initial conditions do not permit as complete a study of transient behavior as is desirable, so considerable effort has been expended in extending the class of initial conditions which may be employed with Heaviside's calculus.

The following simple change of variable permits the use of Heaviside's expansion theorem to include all linear lumped networks with no restrictions as to initial conditions.

Let

$$\int_0^t i(\lambda)d\lambda = q(t) - q(0) \tag{1}$$

and

$$q(0) = 0 \tag{2}$$

If $i(t)$ represents a cyclic or mesh current, $q(t)$, defined by these equations, will represent the total charge which flows past a circuit point during the time interval 0 to $t$ as a result of the current $i(t)$. The charge $q(t)$, called the mesh or cyclic charge, may or may not represent the actual charge on a capacitor in the network. This mesh or cyclic charge, according to equation 2, will always be initially zero.

Next let $q'(t)$ be defined by

$$q(t) = q'(t) + t \cdot i(0) \tag{3}$$

and note that

$$q'(0) = 0 \tag{4}$$

because of equations 2 and 3. This charge $q'(t)$ may have little, if any, physical significance. Now let a second change of variable be made according to

$$i'(t) = \frac{d}{dt} q'(t) = p \cdot q'(t) \tag{5}$$

Substituting for equation 3, this equation is

$$i'(t) = p \cdot q(t) - i(0) = i(t) - i(0) \tag{6}$$

Therefore,

$$i'(0) = 0 \tag{7}$$

That is, the initial value of $i'(t)$ is zero, no matter what the initial value of $i(t)$.

Therefore, if the equations of a network are expressed in terms of $i'(t)$ and $q'(t)$, the initial conditions will always be zero, and Heaviside's expansion theorem applies. Once $i'(t)$ or $q'(t)$ are determined, $i(t)$ and $q(t)$ may be established from the foregoing equations.

The following example will show the method of employing the change of variable defined in the preceding to solve a network problem. The network shown in figure 1 will be considered.

The voltage equations for this circuit in terms of mesh and capacitor charges are (switch in $b$ position)

$$E=(Lp^2+Rp)\cdot q_1(t)-Lp^2\cdot q_2(t) \tag{8}$$

$$O=-Lp^2\cdot q_1(t)+Lp^2\cdot q_2(t)+\frac{1}{C}q_{34}(t) \tag{9}$$

Since from the definition of mesh charges, the charge on any capacitor is the algebraic sum of all the mesh charges associated with the branch of the capacitor and the initial charge on the capacitor

$$q_{34}(t)=q_2(t)+q_0 \tag{10}$$

and since for a $V_c$ (the initial voltage drop of the capacitor) assumed direction as shown in figure 1,

$$V_c=-\frac{1}{C}q_0 \tag{11}$$

equations 8 and 9 can be written

$$E=(Lp^2+Rp)\cdot q_1(t)-Lp^2\cdot q_2(t) \tag{12}$$

$$V_c=-Lp^2\cdot q_1(t)+\left(Lp^2+\frac{1}{C}\right)\cdot q_2(t) \tag{13}$$

Next, making the substitution of equation 3, these equations become

$$E-Ri_1(0)=(Lp^2+Rp)\cdot q_1'(t)-Lp^2\cdot q_2'(t) \tag{14}$$

$$V_c-\frac{i_2(0)}{C}t=-Lp^2\cdot q_1'(t)+\left(Lp^2+\frac{1}{C}\right)\cdot q_2'(t) \tag{15}$$

Finally, since from equation 5

$$q'(t)=\frac{1}{p}\cdot i'(t)$$

these equations may be written in terms of the primed currents and the unit function as

$$[E-Ri_1(0)]\mathbf{1}=(Lp+R)\cdot i_1'(t)-Lp\cdot i_2'(t) \tag{16}$$

$$\frac{CV_cp-i_2(0)}{Cp}\mathbf{1}=-Lp\cdot i_1'(t)+\left(Lp+\frac{1}{Cp}\right)\cdot i_2'(t) \tag{17}$$

Solving these equations,

$$i_1'(t)=\frac{[E-Ri_1(0)+V_c]p^2-\frac{1}{C}i_2(0)p+\frac{E-Ri_1(0)}{LC}}{R\left(p^2+\frac{1}{RC}p+\frac{1}{LC}\right)}\mathbf{1} \tag{18}$$

$$i_2'(t)=\frac{[E-Ri_1(0)+V_c]p^2+\left[\frac{RV_c}{L}-\frac{i_2(0)}{C}\right]p-\frac{Ri_2(0)}{LC}}{R\left(p^2+\frac{1}{RC}p+\frac{1}{LC}\right)}\mathbf{1} \tag{19}$$

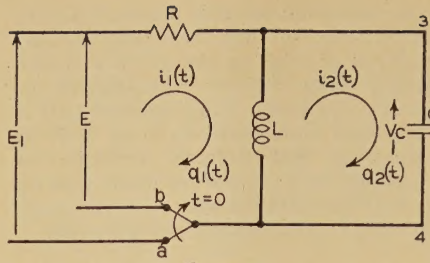


**Figure 1**

Employing the well-known Heaviside expansion theorem to determine the solutions for $i_1'(t)$ and $i_2'(t)$, and then using equation 6 to determine $i_1(t)$ and $i_2(t)$,

$$i_1(t)=\frac{E}{R}+\frac{1}{R}\epsilon^{-\frac{1}{2RC}t}\left\{V_c\cos\omega t+\frac{R[i_1(0)-i_2(0)]-\frac{1}{2}V_c-E}{RC\omega}\sin\omega t\right\} \tag{20}$$

$$i_2(t)=\epsilon^{-\frac{1}{2RC}t}\left\{\frac{E-R[i_1(0)-i_2(0)]+V_c}{R}\cos\omega t+\frac{R[i_1(0)-i_2(0)]+V_c\left(\frac{2R^2C}{L}-1\right)-E}{2R^2C\omega}\sin\omega t\right\} \tag{21}$$

where

$$\omega=\sqrt{\frac{1}{LC}-\left(\frac{1}{2RC}\right)^2}$$

Note that for this particular network only the difference between the initial mesh currents appears. This difference is the initial current in the inductor. It should also be noted that the foregoing method takes care of the initial jump of current in this network. Correspondingly for any network, this method will automatically take care of the initial jumps of cyclic currents in the meshes containing no inductance. This, of course, is an inherent property of the Heaviside method.

The required initial values of the mesh currents must be determined beforehand by solving the network under pretransient conditions and finding the values of the currents and capacitor charges at the time of the transient's initiation.

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# Books Received

**"The Norris Project".** For the purpose of "giving to the engineering profession the important and useful facts about the planning and construction of the Norris dam and reservoir on the Clinch River in eastern Tennessee," a comprehensive report on planning, design, construction, and initial operations of this project, the first water-control project of the Tennessee Valley Authority, has been published, having been prepared from material compiled by the various staffs of the Authority. In addition to covering in detail the design and construction of the dam and power house, the report includes chapters on various project investigations, preliminary studies and designs, employee housing, and other related activities and studies. A separate chapter summarizes the costs of the project. The report comprises 840 pages, and is published in six- by nine-inch size with heavy cloth binding; it is profusely illustrated, including 375 illustrations and 171 tables. Copies may be procured from the Superintendent of Documents, Washington, D. C., at $1.50 each.

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ELECTRICAL ENGINEERING SCIENCE. By A. Morley and E. Hughes. Longmans, Green and Company, London, New York and Toronto, 1940. 256 pages, diagrams, etc., 7½ by 5 inches, cloth, $1.75. Discusses the principles underlying the action of electrical apparatus and machines. Deals with both d-c and a-c machinery and includes chapters on transformers, electrical measurements, accumulators, and the electromagnetic system of units. Practical problems.

ELEMENTS OF ACOUSTICAL ENGINEERING. By H. F. Olson. D. Van Nostrand Company, New York, 1940. 344 pages, illustrated, 9 by 6 inches, cloth, $6.00. An exposition of the fundamental principles used in modern acoustics as applied to communication, sound reproduction, and architecture, with a description of existing acoustical instruments. Develops analogies between electrical, mechanical, and acoustical systems. Measurements and testing procedures are discussed and a chapter is devoted to speech, music, and hearing.

ELEMENTS OF ELECTROMAGNETIC THEORY. By A. W. Duff and S. J. Plimpton. Blakiston Company, Philadelphia, 1940. 173 pages, diagrams, etc., 9 by 6 inches, cloth, $2.75. Outline of the elements of the mathematical theory of electricity and magnetism, based upon a course for undergraduates at Worcester Polytechnic Institute. Topics requiring advanced mathematical knowledge have been omitted.

MATHEMATICS APPLIED TO ELECTRICAL ENGINEERING. By A. G. Warren, with a foreword by A. Russell. D. Van Nostrand Company, New York, 1940. 384 pages, diagrams, etc., 9 by 5½ inches, cloth, $4.50. Presents the mathematical methods of most fundamental value to the electrical engineer. Differential and integral calculus are dealt with most fully, with attention also given to Bessel functions, harmonic analysis, Heaviside's operational calculus, and conjugate functions. Problems.

AMERICAN SOCIETY FOR TESTING MATERIALS, PROCEEDINGS of the 42d Annual Meeting held at Atlantic City, N. J., June 26–30, 1939, volume 39. American Society for Testing Materials, Philadelphia, 1940. 1,344 pages, illustrated, 9 by 6 inches, cloth, $6.00 to members, $9.00 to non-members. Contains summary of proceedings at the annual meeting, reports of the various committees, and technical papers, with discussions.

COSMIC RAYS. By R. A. Millikan. Macmillan Company, New York; University Press, Cambridge, England, 1939. 134 pages, illustrated, 8½ by 5½ inches, cloth, $2.50. Three lectures delivered in 1936 and 1937 by Doctor Millikan are here presented in revised form. The first is on "the discovery of cosmic rays and its general significance". The second, "superpower particles", deals with the experimental technique for investigating them, and is illustrated by cloud-chamber photographs. The third describes investigations of the "earth's magnetic field and cosmic-ray energies".

PROBLEMS AND POLICIES IN INDUSTRIAL RELATIONS IN A WAR ECONOMY. A Selected, Annotated Bibliography. Revised edition, prepared by H. Baker. Industrial Relations Section, Princeton University, Princeton, N. J., May 1940. 30 pages, 9 by 6 inches, paper, $0.25. The books, reports, and articles listed in this bibliography of industrial organization in wartime cover conditions in the United States and Great Britain during the World War and the reconstruction period, legislative developments in the United States affecting current adjustment to a war economy, and discussions of current problems. There is an author index.